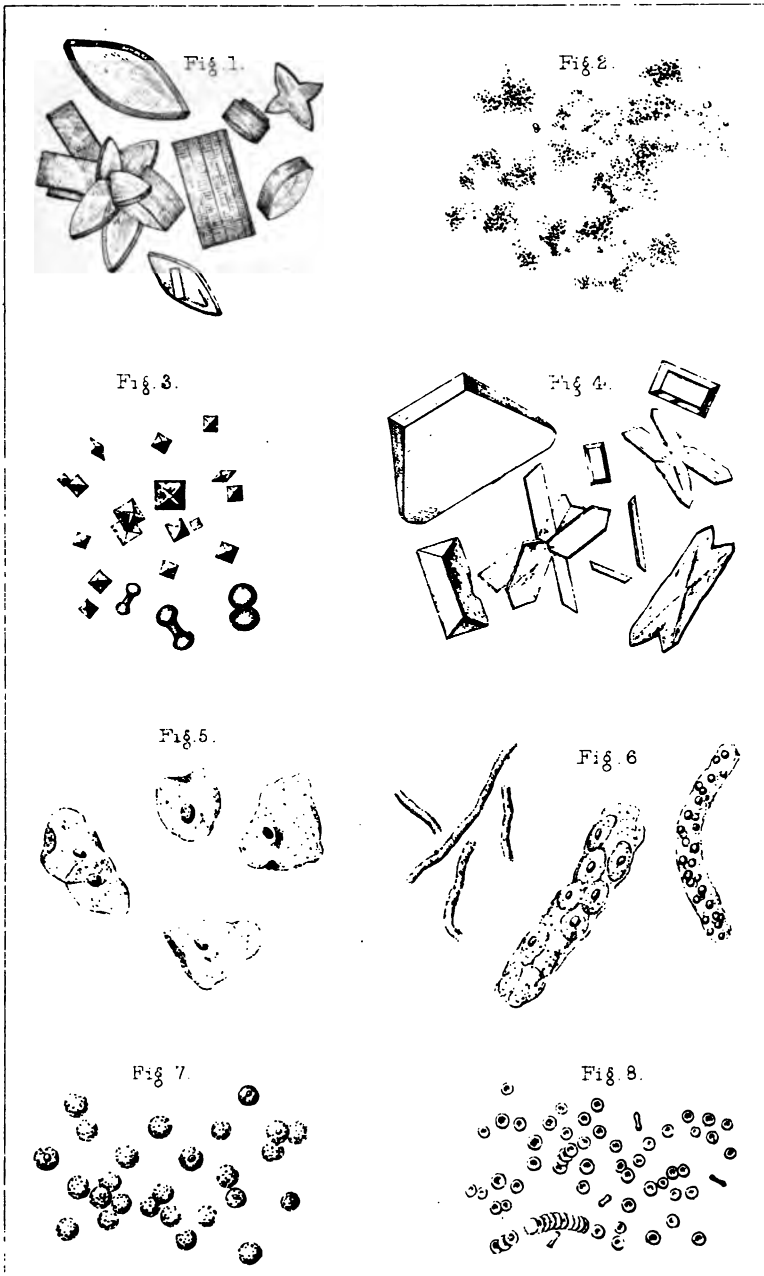
NUTRITION IN HEALTH AND DISEASE



1. Uric Acid.
2 Urate of Ammonia.
3 Oxalate of Lime
4. Tribasic Phosphate.
5. Epithelial Scales.
6 Fibrinous, Epithelial, & oily casts.
7. Pus Globules.
8 Blood Globules.

NUTRITION

IN

HEALTH AND DISEASE

A CONTRIBUTION TO HYGIENE AND TO CLINICAL MEDICINE

γνῶθι σεαυτόν.

"What is food for one is poison for another."

BY

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THIRD EDITION

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PREFACE TO THE FIRST EDITION.

MY object in writing the following work has been to draw attention, forcibly, to the fact, constantly overlooked, that the imperfect performance of the digestive and nutritive functions leads, slowly but surely, to ill-health, to disease, and to death. In order to make myself perfectly intelligible, I have prefaced the pathological details into which I have entered with a brief account of normal digestion and nutrition, as elucidated by modern physiological and chemical research.

The physiological facts and doctrines advanced are those generally received, and will be found more or less developed in all recent treatises on physiology. I am fully aware that some of these doctrines are still a subject of discussion between recent experimentalists, but I have not thought it

desirable to reproduce their different opinions. Had I done so I might have rendered the work more complete, but I should have also marred the brevity and clearness by which I am desirous that it should be characterized.

The pathological facts and opinions brought forward are deduced from my own individual experience, and were briefly enunciated ten years ago, in the second edition of my work on Uterine Inflammation, published in 1848. They agree, in the main, with the views entertained by most modern writers on nutrition and on urinary deposits.

There is, however, one point on which I join issue with many who have specially treated of urinary deposits. I believe that too much importance has been attached to the *differential diagnosis* of the different morbid salts which are found in the urine as a result of disordered digestion and nutrition. I attribute even more importance to the presence of these deposits, as evidences of perturbation of the digestive and nutritive processes, than is usually attributed to them; but after many years' research, I have not been able to establish to my own satisfaction that the different morbid salts have always, or indeed generally, a different pathological

meaning. It appears to me that, in disordered nutritive states, all, or nearly all, may occur and constantly do occur under the same circumstances.

If such is the case, the prevailing views in this very important department of pathology may possibly admit of simplification, and be thereby rendered more practical. It is with no slight hesitation that I have made an attempt in this direction; but I have gathered courage from the reflection that the generalizations of a practical physician, who is constantly seeing and treating chronic as well as acute disease, may not be without some value, even in a field occupied by much more learned labourers.

I trust that I shall not be considered presumptuous, if I express the hope that this little work may contribute to convince my medical brethren of the imperative necessity of studying dietetics in connection with physiology and chemistry. Apart from such a basis, all dietetic views and regulations must be fallacious. No medical practitioner is, in reality, capable of regulating the diet of his patients, in a sound and satisfactory manner, unless he know and bear in mind the chemical nature of the food that he recommends, what it is destined to effect,

and what eventually becomes of it—whether perfectly or imperfectly digested.

In conclusion, I would remark, that the tendency which is rapidly gaining ground to look upon the diseases of the present day as presenting an asthenic character, and as requiring high feeding and stimulants more than depletion and a low diet, renders this knowledge all the more necessary.

It should ever be remembered, that to give a large quantity of food to a patient, however weak and emaciated, which he cannot and does not properly digest, is to partially poison him. On the one hand, imperfectly-digested food does not nourish; on the other, it has to be eliminated from the economy as noxious matter—yet this is an error which is constantly committed.

60, Grosvenor Street,
September 1st, 1858.

PREFACE TO THE SECOND EDITION.

THE preface to the first edition of this work explains the mòtives which led to its publication in 1858. It was received with favour, the entire edition having been exhausted within the year. I did not, however, republish it, because it was my wish to indite a more complete work, one more worthy of the rather ambitious title I had selected, and because I had not the leisure to accomplish this design. Confirmed invalidism overtook me shortly after the essay appeared, and I then determined to follow to the letter the hygienic principles which I had propounded. Indeed it is owing to my having had the courage so to do that I then escaped death, and that now flattering friends tell me that I am a better man, physically, than I was twenty years ago!

One of the rules of conduct that I laid down for my guidance, and to which I have scrupulously adhered ever since, was to do nothing whatever, professionally, scientifically, or even socially, that could not be accomplished between a nine o'clock breakfast and a six o'clock dinner. Such a resolve, steadily carried out, considerably curtails literary leisure, and mars ambitious literary designs. Moreover, my thoughts passed into other channels, and other literary labours took precedence.

Some little time ago I casually took up the all-but-forgotten book, and read it through. My "matured" verdict was that the physiological errors it points out, and the admonitions it gives, apply as much to the present time as to the past, and that it was worth rescuing from oblivion in its pristine shape and form. So I have brought the physiological section up to the present state of science, and have merely revised the second part of the work, according to Horace's rule—(*De Arte Poeticâ*, v. 445):

> "Vir bonus et prudens versus reprehendet inertes,
> Culpabit duros, incomtis allinet atrum
> Transverso calamo signum; ambitiosa recidet
> Ornamenta; parùm claris lucem dare coget
> Arguet àmbiguè dictum; mutanda notabit;
> Fiet Aristarchus!"

I am aware that since the appearance of this

PAGE

renewing acquaintance with the English poets, the friends of early youth, in my country home, reclining in a hammock under the trees. The fact that a sense of duty has led me to sacrifice such a blissful holiday to the revision of former scientific researches must be my excuse, should an excuse be considered necessary, for this reappearance in the field of hygienic and sanitary science.

September, 1876.

THIRD EDITION.

SEVERAL favourable reviews which have appeared recently, in influential quarters, have brought the second edition of this work to an honourable but rather unexpected close. I have once more carefully revised it, and trust that the third edition may continue to deserve the cordial reception given to its predecessors.

THE FERNS, WEYBRIDGE, SURREY,
October 8, 1877.

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CHAPTER I.

DIGESTION AND NUTRITION IN HEALTH.

UNDER the general term of Nutrition may be comprised the various functions and operations through the agency of which the animal economy is developed, its waste is repaired, and its heat is maintained.

Life begins in man, as in all animated nature, by a cell or a series of cells. During fœtal life the materials of nutrition are elaborated and supplied by the mother. But from the moment that parturition has taken place, that the link which united mother and child has been severed, and that the latter begins to live an independent existence, its nutrition must be the result of the action of its organization upon "the materials of nutrition" supplied from the outer world.

The materials of nutrition are obtained from

the atmospheric air breathed and from the food consumed. Out of these materials the organization of the new-born child, perfect in itself, but rudimentary in its development, has to be increased, completed, and repaired.

The human frame is composed, chemically speaking, of gases, Oxygen, Hydrogen, and Nitrogen, of Carbon, Phosphorus, Sulphur, Silicon Chlorine, Fluorine, Potassium, Sodium, Calcium, Magnesium, and Iron. These various substances exist in different states of combination. They are the chemical elements which are eliminated from the air and from food.

The nutritive elements supplied by the atmosphere which surrounds the earth, through the function of respiration, are always the same; the atmosphere being chemically composed of oxygen, nitrogen, and carbonic acid, combined with minute proportions of other gases, such as ammonia and sulphuretted hydrogen. If the atmosphere is pure, they are supplied in the same proportions. They are beyond our control, inasmuch as respiration is carried on from birth to death independently of the will.

Food contains the required chemical elements of nutrition in variable proportions, and instinct guides man and all animated beings in the choice of the kind of food required by his and their organizations. This instinct, however, may be, and often is, marred or perverted in man. The food-instinct is not so

strong with him as it is with the brute creation, the members of which generally limit themselves to the kind of food upon which nature has intended them to live and thrive. Perhaps it is so because he has reason to guide and direct him. It therefore behoves man to make use of his reason, to study himself, and thus to enable his intellect to direct his appetites and food-desires.

The body is principally formed of the three gases above enumerated, oxygen, hydrogen, and nitrogen, and of carbon transformed and solidified by nature's chemistry. The inorganic salts occupy a subordinate but indispensable position. These salts are mainly employed in forming and giving solidity to the tissues, bones, cartilages, and muscles. They are contained in greater or less, but in sufficient quantity, in the various articles of food consumed by animated beings. Thus they enter the economy with the food, imperceptibly, mysteriously, as it were, perform their duty, and are eliminated, without the individual having to look for them, or being conscious, indeed, of their presence, or of the inorganic requirements of his own organization.

In the vegetable world, carbon is the all-important and predominating elementary substance. Hydrogen and oxygen also exist in abundance, either united as water, or in other forms of combination. Nitrogen is scarcely found in some vegetable productions, and seldom constitutes more than

from 1 to 4 per cent. of the whole, even in the vegetable substances which contain it in the largest proportion, such as wheat, oats, hay, etc. In the animal world, nitrogen appears to be in the ascendant, and to constitute the most important element in the animal formation; carbon, oxygen, and hydrogen occupying a secondary position.

Even in the animal creation, however, carbon constitutes the greater part of the bulk. Thus lean beef, white of egg, and the curd of milk, when quite dry, present the following proportions (Professor Johnston):—

	Per Cent.
Carbon	55
Hydrogen	7
Nitrogen	16
Oxygen, with a little sulphur and phosphorus	22
	100

The greater amount of nitrogen contained in animal substances, as compared with vegetable, appears, however, to thoroughly modify their anatomical and physical character, and warrants the distinction generally recognized and established between carbonaceous and nitrogenous, or vegetable and animal, organizations.

This simple fact is at the bottom of the entire theory of nutrition in the organic creation. The framework of an animal being to a considerable

extent formed of nitrogen, it is clear that if the animal is not carnivorous, does not live on flesh, it must consume vegetable food containing nitrogen. And such is the case; the grains and grasses on which frugivorous and herbivorous animals live, all contain, in addition to carbon, a certain quantity of nitrogen.

Carnivorous animals make and repair their nitrogenous flesh-tissues from the nitrogenous flesh of the herbivorous animals; while the latter, as we have seen, elaborate it directly from the vegetable world.

Man, occupying a medium position, and being carnivorous, herbivorous, and frugivorous, can extract the nitrogen he requires either from animal or from vegetable substances, or from both simultaneously. In the first case, he transforms directly the flesh of the nitrogenous tissues of animals into his own; in the second, he extracts from the vegetables he consumes their small percentage of nitrogen; and, in the third, he forms and repairs his own flesh on nitrogen extracted indiscriminately from both kingdoms. In all three, he combines the nitrogen extracted from food with oxygen supplied from the atmosphere, through respiration, in the formation of his tissues.

From the above facts, it must be apparent that man, a considerable proportion of whose body is composed of nitrogen, is compelled to seek nitrogen in his food to complete his structures and to repair their waste. Nitrogen, therefore, he does seek, and

finds, in abundance, in animal substances, such as flesh, milk, eggs, and also, in a smaller ratio, in vegetable articles of diet.

Man, however, like all warm-blooded animals, has not only to complete and renovate the structures which constitute his body,—he has also, from the hour of his birth to that of his death, to *create heat*, in more or less abundance, according to the temperature of the atmosphere by which he is surrounded. Owing to the laws of radiation of heat, there is a constant tendency in all bodies, animate or inanimate, to abandon surplus heat to the medium in which they are placed. In the warm-blooded animal creation, this tendency is only counteracted by the constant generation of heat, which is a result partly of real combustion, and partly of the more intimate vital, electric, and nutritive changes that are constantly taking place in the tissues of the economy. When death supervenes, and these operations cease, the body, at first warm, rapidly loses its heat, and becomes of the same temperature as the surrounding atmosphere. Thus, during life, the animal body is a walking fire, consuming fuel, in the shape of food on the one hand, and of its own detritus on the other, which it combines with oxygen derived from the atmosphere during respiration. In a northern climate like ours, a very considerable proportion of the food taken is thus consumed in keeping up the animal heat.

Combustion, in the external world, is principally

supported by the combination with the oxygen of the atmosphere of carbonaceous substances, such as vegetable products, wood, charcoal, coal, and fats and oils, which are hydrocarbon compounds. Their rapid chemical combination with oxygen is attended with the evolution of heat and light. Were the combination to take place more slowly, heat would still be evolved, but light would not. This is what occurs in the animal economy. The carbon of vegetable food—the principal element of such food—and that of fatty substances and of alcoholic beverages rich in carbon, combines with the oxygen introduced into the circulation by respiration, forms carbonic acid, and evolves heat.

Thus we see that the nitrogenous element in food, represented by flesh or animal substances, is principally required to perfect the tissues of the economy, and to repair their waste; whilst the carbonaceous element, which is represented by vegetable articles of diet, by fats and oils, and by alcoholic beverages, is principally required as fuel, to support the silent combustion which is constantly going on in the animal system, and to which is mainly due the generation of animal heat. It is now generally admitted that the more intimate processes of nutrition, which consist in the constant formation and disintegration of the tissues of which the economy is formed, under the influence of the nervous system, are also attended with the evolution of latent heat in considerable quantities. These sources of heat

continue to create it incessantly as long as life lasts, ceasing their operation with life only.

It was long supposed that carbonaceous food was all but entirely employed or burnt in the generation of heat, and that "force" was derived in the animal economy all but exclusively from the assimilation of nitrogenous food, or sooner from that of the nitrogenous element in food, animal or vegetable. This was Liebig's theory, and his authority long overpowered all opposition or doubts.

During the last few years this point has been investigated by several eminent physiologists, amongst whom I may name E. Smith, Professor Haughton, Dr. Frankland, Professor Fïck, and Wislicenus of Zurich. They have endeavoured to arrive at a clearer and more exact idea than we had before of the origin of the power given out or spent by animated beings.

These experiments have been carried out under the influence of modern views respecting the correlation of physical forces, and the doctrine of the conservation of force and of the equivalency of heat and of mechanical force. They appear to have satisfactorily established that the production of the muscular power spent by animals and man is not so much to be attributed to the assimilation of nitrogenous food as to the slow combustion of carbonaceous food. According to this view the formation of animal heat by the combustion of carbon, and the final assimilation and nutrition processes gene-

rally are attended with the development of "force," of which the muscles may possibly be only the instruments, not the producers.

This theory may be familiarly illustrated and explained by the steam engine. The latter, in burning coal, carbon, does not only produce heat, but power, the power that drags the train along. In a more obscure, but equally evident manner, the slow combustion of carbonaceous food in the processes of nutrition is attended with the development not only of heat but of power or force.

If the above views are correct, it would follow, singular as the statement must appear, when viewed by former lights, that more power or strength is to be got out of fat than out of meat or muscular tissue; and this really seems to be the case. Tyrolese chamois hunters find that they can endure greater fatigue on beef fat than on the same weight of lean meat. Accordingly, when about to absent themselves for several days in the higher mountains, hunting, they take beef fat with them instead of lean meat.*

Thus is fully explained the craving of mankind for fatty food, and for carbonaceous food generally, even in warm weather and in warm climates. Thus is illustrated the generally acknowledged physiological principle that man is omnivorous. These facts also explain the "strength" of the rice-eating Hindoo, of the potato-eating Irishman, of

* See *Intellectual Observer*, July, 1866.

the chestnut-eating Corsican. A rational dietary, however, is evidently one in which nitrogenous and carbonaceous foods are mingled in due proportion.*

Having thus briefly stated what nutrition is, and analyzed the materials on which it depends, I shall examine the various stages of elaboration through which these materials have to pass. It is not my intention, however, to enter minutely into the history of the various functions which, by their united action, constitute digestion and nutrition. I am merely desirous to give a brief sketch of the facts established by the researches of modern physiologists, in order to render intelligible the subject of nutrition in general, and more especially that of morbid nutrition. It is my wish thus to establish, on a sound and irrefutable basis, the views which I shall have to develop in the second part of this work.

SOLID FOOD, ITS ELABORATION AND DESTINATION.

Liquid food introduced into the mouth is swallowed at once, and passes into the stomach. If solid, it has to undergo the preliminary process of mastication. During mastication it is freely mixed with the alkaline saliva, which is poured out in abundance from the salivary glands, and which

* See my work, "On the Treatment of Pulmonary Consumption by Hygiene, Climate, and Medicine," 2nd edition, p. 93, *et seq.*

much facilitates the process. Liquid food passes into the stomach with comparatively little admixture of saliva. Solid food, on the contrary, whilst being ground and divided, is saturated with salivary secretion, which gradually forms it into a pulp fit for the action of the gastric juices. From the various experiments that have been performed it would appear that the subsequent changes produced in solid food by the stomachal digestion are much facilitated by the presence of the saliva.

The saliva also appears to have a peculiar power of transforming the insoluble starch of farinaceous food into soluble dextrine and grape sugar, a necessary transformation in the series of food changes. This is the more remarkable as the gastric juices do not possess this power. They appear to act more especially as a solvent of the nitrogenous food element.

Saliva does not seem to act chemically on the other principles of food, so that in carnivora, who live only on flesh, it appears to be simply destined to soften and lubricate the aliment.

As soon as food reaches the stomach its presence determines the secretion of the gastric juice, which is not found in that organ during the period of vacuity or repose. This secretion exercises a very peculiar dissolving power over the food which is submitted to its action, gradually reducing it to the condition of a grey creamy or pultaceous fluid. The time employed to effect this dissolution varies according to the nature of the food; animal

substances, as a rule, taking longer to digest than vegetable.

The period of stomachal digestion is one of great vital activity for that organ. The contact of food with the coats of the stomach is immediately attended with an influx of blood to its mucous membrane, which becomes highly vascularized. In this mucous membrane are innumerable glands, imbedded as it were in longitudinal bundles in its tissue, with their orifices opening on its surface. These minute glands secrete the gastric juice, which they accomplish by the successive formation and rupture of the cells that contain it. The quantity of the secretion is very great; it is estimated at from ten to fifteen pints in the twenty-four hours.

The muscular structures of the stomach are at the same time contracting actively, so as to bring successively each portion of the food in contact with the mucous membrane from which gastric juice is pouring uninterruptedly. These contractions also carry off, towards the pylorus and intestines, that portion which has been dissolved and elaborated.

The gastric juice is acid, a property it owes to its containing lactic or hydrochloric acid, and the superphosphate of lime. Its digestive properties depend on a peculiar animal matter, to which the name of pepsine has been given, and which may be extracted in the shape of an amorphous powder. A solution of pepsine will dissolve meat or any other alimentary substance, but only at a tempe-

rature similar to that of the body, that is, at from 98·5° to 99·5° Fah.

When empty the stomach, which may be termed in some senses a large muscle, contracts on itself. When it contains solid food it contracts firmly on the food, and forces it round and round the large curvature of the stomach, and then back to the œsophageal orifice by which it entered. As the food dissolves and assumes the character of a creamy pultaceous fluid, which is termed chyme, it escapes from the above-described circuit, is directed towards the pylorus, and passes into the intestines. Fluids are, in a great measure, directly absorbed by the walls of the stomach, which sift out and retain their solid constituents.

The time employed by the stomach in thus digesting or dissolving food varies according to its nature, and according to the individual. Various means have been resorted to with a view to solve this question. Animals have been killed at different hours after the ingestion of food; food has been placed in hollow perforated balls tied to a string, by means of which they could be withdrawn at any time; or vomiting has been artificially induced. The most conclusive experiments, however, were those of Dr. Beaumont, of New York, on a young Canadian named St. Martin, which have been quoted by all recent physiologists. Dr. Beaumont's patient, a healthy young man, had received a gunshot wound just over the stomach,

which exposed and opened that organ. The wound, on healing, left a wide fistulous perforation, which had to be closed artificially, by a plug. On removing this plug the food could at any period of digestion, be abstracted and examined, and the state of the stomach and of its secretions could be investigated.

Dr. Beaumont went through a very extended series of observations with his patient, and came to the conclusion that cooked vegetables and fluid animal substances were easier and sooner digested than flesh; and that the comparative rapidity of the digestive process depends principally on the degree of cohesion of the tissues exposed to it, that is, on their tenderness or toughness.

According to the table published by Dr. Beaumont, the following were the principal results noticed:—rice and tripe were digested or chymified in an hour; eggs, salmon, trout, apples, and kept venison, were digested in an hour and a half; tapioca, barley, milk, liver, fish, in two hours; turkey, lamb, potatoes, in two hours and a half; fowls, beef, and mutton, in three hours and a half; veal in four hours. The same results were obtained on macerating these substances in the man's gastric juice, out of the stomach.

The results obtained by other observers have varied, more or less, according, no doubt, to individual idiosyncrasy or peculiarities, and to state of health at the time of the experiments. From

my own experiments and observation, principally directed to the state of the urine after food, I think I am warranted in giving the following list as a guide to be generally relied on in estimating the comparative digestibility of different articles of food: milk, eggs, broths and light soups, cooked vegetables, fish, fowl, game, lamb, mutton, veal, beef, salted meat, including ham and bacon. The time occupied in the digestion of these alimentary substances, before they reach the blood, and modify the urine, varies from two hours for the lighter food—such as eggs, milk, broths, to five hours for the more dense alimentary substances, and more especially for salted meats, ham, beef, and bacon.

The chemical changes that take place in the stomach are important. The fibrin and the albumen of animal tissues and fluids are chemically acted upon by the gastric juice, and appear to be converted into a low form of albumen, not precipitable by nitric acid or by heat, and now generally termed *albuminose* or *peptone*, from which they are later to be again elaborated. The same change probably takes place in the nitrogenous elements of vegetable food. The other elements of vegetable substances are principally sugar, gum, lignin, and starch. The sugar, gum, and dextrin which are soluble, are probably dissolved at once, and absorbed; whilst the insoluble starch that has not been converted into dextrin or sugar in the stomach, probably undergoes that transformation in the

duodenum under the influence of the pancreatic secretion. The action of heat in cooking expands and breaks the starch granules, thus rendering them more easily acted upon.

The oleaginous elements, including all oils, fats, butter, are not chemically modified by the stomachal digestion; they are merely separated and reduced to a minute state of division.

The fluids ingested, in whatever shape it may be, are mostly absorbed in the stomach itself, and thus furnish a material or element for the very abundant glandular secretions of the stomach, intestines, and accessory organs.

On leaving the stomach, the chyme becomes mixed with the secretions of the pancreas and of the numerous minute glands which are situated in the mucous membrane of the small intestines. The secretion of the pancreas, a gland of considerable size, is abundant, alkaline, and presents the same physical properties and chemical composition as the saliva. It appears destined to perform in part the same office, as it also possesses the power of transforming into dextrin and sugar granules of starch that have escaped the action of the saliva in the mouth or in the stomach. It is also supposed that one of its offices is to prepare fatty principles for easier absorption, by transforming them into a kind of emulsion capable of being absorbed by the lacteals. This conclusion has been arrived at partly by direct experiment, and partly from induction.

In the food of purely carnivorous animals there is little or no starch, and yet the pancreas exists in them as well as in frugivorous, herbivorous, or omnivorous animals.

The duct from the pancreas often opens into the intestines by a joint canal with that from the liver, and when this is not the case the two ducts are in close proximity. Thus these two secretions mingle, and it is probable that the result of their union is a compound secretion possessed of peculiar properties for promoting the digestive elaboration of the chyme, and for preparing it for absorption by the lacteals.

The liver is a large gland, the secretion of which, bile, is very abundant. The amount of bile secreted in the twenty-four hours is variously calculated to be from one to two or three pints. The secretion is retarded during fasting, and accelerated by the ingestion of food. From the numerous and important physiological researches that have been made in modern times, it appears that the biliary secretion has a double function to perform. On the one hand it is excrementitious and purifies the blood of carbon and hydrogen, the products of molecular disintegration, and of the components of imperfectly digested and unassimilated chyle; on the other hand it is digestive, and performs an important part in the digestive process.

Bile is principally composed of carbon and hydrogen, which it separates from the portal blood, loaded

as that blood is with albuminous and amylaceous products directly absorbed from the food in the intestines. According to Liebig, it yields on analysis—carbon, 76 atoms; hydrogen, 66; oxygen, 22; nitrogen, 2, and a certain quantity of sulphur. Thus the portal blood is purified by a process which we may partly compare with respiration; which, under certain circumstances, it may partly or wholly replace, as during fœtal life. In respiration the carbon and hydrogen in excess in the venous blood combine with the oxygen of the atmosphere, and form carbonic acid and water.

In the liver the carbon and hydrogen of the portal blood are merely transformed by the secretive process into bile. In both cases, however, the venous blood is purified. During fœtal life the purification of the blood appears to be entrusted to the liver only, and on birth the intestinal canal is found filled with bile in the shape of meconium. In warm climates, and in temperate climates when the weather is warm, respiration is less active, and consequently less efficient in purifying the blood of its carbon and hydrogen. As a compensation the secretory activity of the liver increases, and hence, partly, the frequency of liver disease in these climates and seasons.

Until a recent period, the liver was merely looked upon as a secreting, purifying organ. The researches of Bernard of Paris, and of other physiologists, have revealed important functions which

were not even suspected, and which quite justify the views of pathologists of former days as to the pathological importance of the organ.

First, it would appear, from M. Bernard's experiments, that the low form of albuminous matter which reaches the liver by the portal vein from the intestines undergoes in that organ some kind of modification which renders it susceptible of assimilation.

The experimental proof of this fact is, that if this albuminous matter is injected into the jugular vein it is eliminated by the kidneys. If, on the other hand, it is injected into the portal vein, so as to pass through the liver before reaching the heart and lungs, it is not excreted by the kidneys as a foreign substance, but probably incorporated with the albuminous part of the blood.—(Kirke's "Physiology," 9th Edition.)

Secondly, the same series of experiments proves that the saccharine and amylaceous principles of food which pass through the portal vein into the liver undergo some like change, which renders them very similar to glucose or diabetic sugar, and assimilable. If cane sugar is injected into the jugular vein, it is speedily thrown out of the system by the kidneys. If, however, it is injected into the portal vein, and thus passes through the liver before it enters the lungs, no trace of it appears in the urine. —(*Idem.*)

Thirdly, Bernard has proved that the liver has

the power of forming glucose or grape sugar out of principles in the blood which contains neither saccharine nor amylaceous substances, as with carnivorous animals that live exclusively on flesh. Indeed, it would appear that the liver in all classes of animals is continually engaged in forming sugar, or a substance closely allied to it, in large amount. Sugar is always found in the liver, even when absent from all other parts of the body. This sugar is not formed at once in the liver. The latter has the power to produce a peculiar substance allied to starch, which is readily convertible into glucose when in contact with any animal ferment. This substance has been called glycogen—animal starch or hepatin.—(*Idem.*)

One of the most difficult questions in physiology, and one which can scarcely be said to have been yet decided, is the part performed by glycogen in nutrition. Bernard believes that it is converted into glucose in the liver during life, in health as well as in disease, and is carried by the blood of the hepatic veins to the heart and lungs, there to be consumed in respiration. Pavey and other observers assert that it is the glycogen itself which is carried by the hepatic veins to the heart and lungs, the conversion of glycogen into sugar not taking place during life, but only after death. Both these views are supported by many ingenious experiments, for which I must refer my readers to the standard works on physiology.

If Bernard's theory is correct, that the glycogen of the liver is transformed into sugar in the liver itself, and is conveyed by the hepatic veins to the heart and lungs to be burnt—the blood of the hepatic veins must contain sugar. If the amount of sugar thus formed is too great to be burnt in the lungs, it would appear in the blood generally. Its elimination by the kidneys would constitute the disease known as diabetes or glycosuria. The injuries of the nervous system, brain and sympathetic, which are known to cause glycosuria, no doubt produce this result by acting on the sympathetic nerves of the liver, thus leading to altered or depraved functional activity.

Thus the liver appears to have two principal functions to perform—the secretion of bile and that of glycogen. The former secretion, bile, is principally excrementitious, and passes by the biliary duct into the intestines; the latter, glycogen or sugar, passes directly into the lungs, and contributes an element to the functions of respiration.

During digestion, bile, which thus flows into the small intestine along with the pancreatic fluid, mixes with the chyme shortly after it has passed out of the stomach. This mixture of the bile with the chyme no doubt modifies its character, and fits it still further for its absorption by the lacteals. It operates also as a stimulus on the entire intestinal canal, promoting its action and the excretion of the residue of the food, as shown by the constipation

which accompanies jaundice, when the excretion is temporarily arrested; and by the diarrhœa which follows bilious fluxes. It is worthy of remark, however, that in health the greater part of the bile is reabsorbed in the intestinal canal, not more than one-sixteenth, it is presumed, passing away with the motions.

The chyme or food which has undergone the stomachal digestion, on passing out of the stomach by the pylorus is composed of albuminose, or the transformed nitrogenous element of food, of the starch or amylaceous elements that have escaped transformation into dextrin and sugar, of fatty matters dissociated but not yet fit for absorption, of gastric juice, of some portion of the fluids swallowed, and of the indigestible portions of food destined to be expelled with the gases. It becomes alkaline, instead of acid, after mixing with the pancreatic and biliary secretions, and is then more homogeneous, more consistent, and darker in colour. Thus elaborated, it has become fit for the absorbent process which now commences. The soluble portions of the chyme are successively presented to the surface of the small intestine as it is propelled along its course, and are absorbed, the fat chiefly by the lacteals, the albuminous and amylaceous elements partly by the lacteals, but chiefly by the blood-vessels. The lacteals are very numerous in the small intestine, and more sparse in the large. By this process the fatty, albuminous, and saccharine

elements are taken up, as also the bile and the salts in part. When the chyme reaches the large intestine it is still liquid, and begins to assume the peculiar fæcal odour, owing probably to some peculiar product of secretion thrown out in the lower portion of the small intestine. The circumstance of the mucous membrane of the large intestine being devoid of the large villi of the small intestine, points to the fact that the processes of digestion are in a great measure accomplished.

The power of absorption, however, is still considerable, and becomes more and more so as the contents of the large intestine approach the anal outlet in the form of fæces. The latter are composed of the non-nutritive part of the food, viz., woody fibre, vegetable and animal epidermic detritus, mucous corpuscles, colouring matter of the bile, salts, also the fatty amylaceous and albuminous matter unmodified by the digestive process.

The stomach and intestines, both large and small, contain a considerable amount of gases in health, which distend them and give them their form. These gases are found to be composed of oxygen, nitrogen, carbonic acid, hydrogen, carburetted hydrogen, and sulphuretted hydrogen, in various proportions. They are introduced in swallowing, or developed by the decomposition of food and of the secretions.

The chyle which at first fills the lacteals presents

the appearance of a milky fluid. This appearance it owes to the fatty globules, in a minute state of division, which it contains. These globules are supposed to be surrounded with albumen, which prevents their coalescing. The fluid in which they swim contains albumen in solution. After it has passed through the ganglia to which the lacteals converge, this fluid presents corpuscles similar in form to those of the blood, to which the name of chyle corpuscles is given. Fibrin is also found in the chyle, which has evidently been formed out of the albuminous element. The chyle corpuscles become more and more perfect, and more like true blood corpuscles as the chyle advances towards its destination, the jugular vein; until in the upper portion of the thoracic duct, they often assume the red colour of the latter. The fibrin also increases in quantity in the same proportion. Thus the more the chyle, the result of the digestive process, approaches the point at which it is thrown into the current of circulation, the more it assumes both the microscopic aud chemical characteristics of the blood, which it is evidently destined to renew.

Both chyle and lymph, which chyle closely resembles, contain, like the blood, albumen, fibrin, and fatty matter, and the salts of the blood, including iron.

By this same channel, the thoracic duct, is also thrown into the current of circulation the fluid

collected by the lymphatic vessels from most parts of the body. These vessels, originating in nearly all parts of the economy by minute radicles, lymphatic capillaries, closely-meshed net-works, or in irregular lacunar spaces between the various structures, pass through ganglia, like the lacteals, and converging, finally terminate in the thoracic duct, or in the right internal jugular vein. The communication between the blood capillaries and the lymph capillaries takes place, it is now admitted, without any direct or special communicating channels, but simply by the exudation or straining through the walls of the blood capillaries of the fluid part of the blood. It has been proved of late that blood corpuscles can pass readily through the walls of the blood capillaries.

The lymphatic vessels contain, at first, an albuminous fluid like the lacteals, but clear instead of milky, owing to the absence of the fatty particles. Lymph corpuscles and fibrin appear on their emerging from the ganglia, or in the larger trunks, and both the perfection of the corpuscles and the quantity of the fibrin increase as they approach their termination. The lymphatics, like the lacteals, evidently perform an important part in the renewal of the blood; but, unlike the lacteals, the renovating elements they contain and elaborate are drawn, not from the food, but from the blood itself, and the tissues it creates.

To complete this sketch of the sources from

which the blood, the grand element of nutrition, is derived, we must not forget that, as we have seen, part of the chymous fluid is absorbed by the intestinal veins, and is carried directly by the portal vein to the liver, and that there it is elaborated and eliminated in the shape of glycogen and bile; the greater portion of the excreted bile being again absorbed in the small intestine.

Thus we find the chyle which enters into the circulation by passing from the thoracic duct into the jugular vein is, in reality, new blood. This new blood is elaborated out of the chyme and bile absorbed in the intestines and out of the fluid brought by the lymphatic vessels from the capillary tissues. The quantity of chyle thus contributed in the twenty-four hours is very considerable, amounting, it is supposed, to as much as one-third or two-thirds of the weight of the blood contained in the body. This fact proves how rapid and constant must be the nutritive processes, for the weight of the blood of a healthy adult is calculated at about twenty-eight pounds.

The new, or lacteo-lymphatic blood, reaches the right heart along with the venous blood, returning from the different parts of the body. It is propelled by the right ventricle into the lungs, and as it passes through the capillary vessels which form the connecting link between the pulmonary artery and vein, it comes in contact with the atmospheric air, introduced by respiration into the pulmonary cells,

around which the capillaries in question are spread. It is at this stage of the pulmonary circulation that the chemical changes of respiration take place—changes which modify the air inspired on the one hand and the blood on the other.

The atmospheric air which enters the lung in inspiration is composed of seventy-nine volumes of oxygen and twenty-one of nitrogen in every hundred. It also contains a small amount of carbonic acid, in the proportion of about four or five volumes in 10,000, and watery vapour, with occasional traces of ammonia, sulphuretted hydrogen, etc. The air which is emitted from the lungs in expiration, has lost part of its oxygen, and has gained a considerable amount of carbonic acid and watery vapour, the nitrogen remaining the same; a small amount of organic matter and of free ammonia is added.

The amount of carbonic acid thrown off is very considerable, representing about 160 or 170 grains of carbon per hour, or more than eight ounces in the twenty-four hours. The amount exhaled varies according to age, sex, muscular power, temperature of the air, its purity and other circumstances. If the air inhaled is already loaded with carbonic acid the quantity exhaled from the lungs is very much diminished. According to Liebig, the lungs and skin together would emit as much as 10·5 ounces during the twenty-four hours.

The experiments which Liebig and other observers have made prove that a considerable pro-

portion of the carbonic acid eliminated by the blood passes off through the skin. The skin thus becomes a species of respiratory organ, which greatly assists the lungs in purifying the venous blood of the surplus carbonic acid which it contains. Thence the evident necessity of keeping its pores open by frequent ablutions and by friction. In the lower tribes of animals, and especially in the Batrachia, such as frogs, toads, whose skin is thin and moist, life may be long supported by cutaneous respiration alone.

The carbonic acid thus evolved in respiration is to be attributed to the combination of the carbon of the blood with part of the oxygen, which disappears during respiration. This evolution of carbon from the lungs is necessary for the purification of the blood; and as it is retarded, indeed arrested to a great extent, by the presence of an undue proportion of carbonic acid in the air we breathe, the pernicious influence of an atmosphere loaded with this gas can be easily understood. Thus is explained, in part, the injurious effects of the atmosphere of crowded, badly ventilated, brilliantly lighted rooms.

Part only of the oxygen which disappears during respiration is consumed in the formation of carbonic acid. The number of cubic inches of carbonic acid exhaled in an hour being about 1345·3, the quantity of oxygen required for the formation of the carbonic acid is about 1583·6. The surplus oxygen is generally supposed to be consumed in the more intimate or capillary structures of the body, to combine on

the one hand with the albumen which forms the new tissues, and on the other with the nitrogen of the decomposing nitrogenous tissues, as also with the sulphur and phosphorus of the body, thus forming parts of the acids of the sulphates and phosphates that are excreted in the urine. From experimentation it does not appear that the amount of oxygen absorbed by animals is increased by its being present in excess in the atmosphere breathed.

It has been questioned whether nitrogen is exhaled or absorbed during respiration, and it appears probable that in very small proportions both conditions may be observed, exhalation, however, rather being the rule, except in prolonged fasting, when absorption is usually observed. Neither the absorption nor the exhalation of nitrogen, however, is sufficiently active or important to deserve taking into consideration in recalling the changes that occur in the nutritive fluid, the blood, during respiration. The principal use of the nitrogen of the atmosphere appears to be to mechanically dilute the oxygen.

It is worthy of notice that the air inhaled is always returned saturated, or all but saturated, with moisture, and that the quantity of water vapour thus lost is considerable, ranging to from six to twenty-seven ounces, according to the hygrometric state of the air breathed. The dryer the air is, and the higher its temperature, the greater the amount of watery vapour thrown off to effect its saturation.

The amount exhaled under ordinary circumstances, is, probably, nine or ten ounces.

Respiration occasions great changes in the blood itself. It loses its dark crimson venous hue, and assumes the bright scarlet colour of arterial blood. Its temperature is raised by 1° or 2° F.; the quantity of oxygen which it contains is increased; that of carbonic acid and nitrogen is diminished, and the fibrin becomes more abundant, whence the greater coagulability of arterial blood.

It was formerly supposed that the oxygen of the atmosphere united directly with the carbon of the venous blood in the lungs to form carbonic acid, and that heat was thus generated. It has, however, more recently been proved that venous blood contains twenty-five per cent. of carbonic acid for twenty contained in arterial blood, whilst arterial blood contains ten per cent. of oxygen as compared with five per cent. contained in venous blood. Moreover, the heat of the blood in the lungs is scarcely, if at all, greater than that of other parts of the body, which would not have been the case had the carbonic acid evolved in respiration been directly formed in the lungs, and had the latter organs been thus the focus and distributors of heat to the economy. From these well-established facts has been drawn the conclusion that the greater part of the carbonic acid evolved during respiration is not formed in the lungs, but merely thrown off by the venous blood during respiration.

According to this view, the one now generally adopted, the carbonic acid is formed in the ultimate or elementary tissues of the economy by the union of the oxygen absorbed during respiration, and carried by the arterial blood to the capillaries, with the carbon resulting from the disintegration of these tissues, and also with the chyle-wafted carbon supplied by food and not converted into tissue. Simultaneously with this generation of carbonic acid, water is also formed by the union of part of the same oxygen with the hydrogen of the tissues and of the food elements. These chemical and organic changes are attended with the evolution of heat, which is thus constantly emitted in every part of the body, and probably with the development of force.

Whilst the oxygen absorbed by the arterial blood is thus combining with the carbon and hydrogen furnished by the disintegration of tissue, and by recently digested food, to form carbonic acid and water, the still more obscure and mysterious function of molecular nutrition is also taking place. The minute divisions of the systemic capillaries bring the arterial blood in connection with the various structures which compose the economy, penetrating them in every sense, or spreading a network on their surface. These tissues have the vital power of selecting from the arterial blood, chyle renovated, the elements they require for their growth and for the repair of the waste that is constantly taking place in them.

For the nutritive process to take place in a normal manner, the blood must be healthy, and there must be a due supply of nervous power. The process itself appears to be essentially a vital one, each tissue forming itself and repairing its waste from the same blood element. Each particular tissue has, no doubt, its individual duration of life, after which it is broken up and is superseded by new particles, new tissue. Thus every component part of the animal organization has its average duration of life, and then degenerates and dies, to be superseded and replaced.

The entire series of nutritive processes above described take place under the direct control of the nervous power of the individual, an important physiological fact which explains the influence of nervous exhaustion and depression in producing diseases of nutrition.

Change, constant change, is, therefore, the law of organic life. The molecular elements of the tissues of which the animal economy is composed are constantly dying, being resolved into their chemical elements, and are as constantly renewed. This renovation, this repair, takes place principally, as well as the original formation, out of the nitrogenous elements of the blood, the albumen and fibrin. All influences that arrest, in an appreciable manner, these organic changes must, if prolonged, be prejudicial to nutrition.

THE FINAL DESTINATION OF SOLID FOOD: ITS ELIMINATION WHEN TAKEN IN EXCESS.

We have traced solid food through its various phases of elaboration up to its final destination. It was stated at first that articles of food may be divided into two great classes, the nitrogenous and the non-nitrogenous; that nitrogenous food is principally represented by animal substances, in which nitrogen is the prominent element, whereas non-nitrogenous food is represented by vegetable substances, principally composed of carbon—nitrogen being present only to a much more limited extent.

We have now arrived at the explanation of these facts, and find that nitrogenous food is principally used in repairing the wear and tear of our tissues, in forming nitrogenous flesh compounds; whereas the carbonaceous and vegetable food furnishes nitrogen in small quantity, and is principally employed in supplying materials for animal heat and force.

The organic changes that take place during nutrition—during the formation and consolidation of tissues out of the blood, and during the disintegration of these same tissues—are attended with the evolution of heat; but the heat thus produced is not alone sufficient to keep up the temperature of warm-blooded animals to their natural standard, surrounded as they usually are by a much lower temperature. To compensate for the constant

radiation and loss of heat, part of the chemical elements of the food consumed is burnt.

The union of oxygen with carbon and hydrogen which constantly takes place in the animal economy is an example of combustion as perfect as that of the oil in a lamp, or as that of coal in a fire, and is attended with the same evolution of heat. The only difference is, that with the lamp or fire the combustion is rapid, and attended with the evolution of light and flame; whereas, in the animal economy, it is slow, and unattended with these merely accessory phenomena; the heat is gradually and imperceptibly emitted. The slow combustion of the chyle-transformed carbonaceous elements of food probably commences as soon as the blood has become loaded with oxygen in passing through the lungs, although the principal change no doubt takes place in the systemic capillaries.

Owing to the ever-varying food requirements for the production of heat, in accordance with temperature, warm-blooded animals are exposed to a double diet difficulty or error. They may not take enough heat-producing food, in which case they are cold, chilly; or they may take too much, and the excess has to be eliminated. The same difficulty occurs with the tissue-producing or nitrogenous element of food: too little or too much may be taken. In the former case the economy is under-fed, and waste of tissue, emaciation, occurs; in the latter, the oversupply has to be eliminated.

Whenever one or other kind of food, or both, are taken in excess, a portion, greater or less, passes undigested, or partly digested, through the intestinal canal, and is excreted with the fæces, giving rise to abnormally large motions. More, however, may be transformed into chyle and absorbed than is required by the wants of the system, and in such a case it has to be eliminated.

In healthy digestion the chyle-transformed food, which is not employed in repairing the waste or increasing the volume of our tissues, and which is not burnt to produce heat, is eliminated by the kidneys, liver, and skin in various forms of chemical combination, but principally in the shape of urea and bile. It may be presumed, however, that in a state of health, and under a properly regulated system of diet, the amount of chylified nutritive materials is not greater than the economy can dispose of in the legitimate physiological modes.

When the powers of the economy are overtaxed by a greater amount of food supply and of chyle formation than can be thus disposed of, the carbon in excess appears to be eliminated by a superabundant secretion of bile, and by the deposit of fat in the tissues, whilst the nitrogen in excess appears to be eliminated by the kidneys in the shape of a superabundance of urea, of uric acid, or of urate of ammonia and soda.

The urea normally found, under all circum-

stances, in the urine, of which it may be termed the chief solid component (14·230 in 1,000 parts), is no doubt principally the result of the normal wear and tear, or disintegration of tissue. Uric acid and urate of ammonia and soda are present in normal urine, but in minute proportion. Their presence in excess, as also that of urea, may be looked upon as the evidence either of an over-supply of nitrogenous food material, of diseased nutritive action, or of a too rapid disintegration of muscular tissue. Thus the kidneys are the great nitrogenous emunctories or purifiers of the blood.

In the process of normal nutrition, the different tissues of the economy have the power of extracting from the blood the various salts which they require. Thus it is that the bones and the brain extract the phosphate of lime which forms so important a part of their composition, and that other tissues select the salts which predominate in their structure. In each case the selection is made by their own inherent force of vitality. When these tissues have lived their time and are disintegrated, the chemical elements of which they are composed are thrown out of the economy to make way for new molecular formations.

Whether healthy or morbid, the urine principally contains salts and nitrogenous products, such as urea, creatin, and creatinin, two crystallizable substances, derived probably from the metamorphosis of muscular tissue. The kidneys may be

said to be large secreting filters, the duty of which, in health, is to throw off the surplus fluids taken into the system, to eliminate the soluble products of the disintegration of tissue, and also to eliminate from the blood the nitrogenous elements of food, imperfectly digested, imperfectly chylified, and, as such, unfit for assimilation.

When we consider that all the blood in the body passes through the kidneys every few minutes, we shall better be able to appreciate the very great preservative powers which the kidneys exercise in this respect—powers which are very generally overlooked, and to which we shall at a later period devote careful attention.

FLUID FOOD, ITS ELABORATION AND DESTINATION.

We have said little as yet of beverages or of fluid food. Water, the basis of all, is composed of oxygen and hydrogen, and may no doubt be decomposed, and yield its elements to the animal economy in its passage through the system. It is probable, however, that to a great extent it retains its chemical integrity during the different phases of its journey, and acts merely as a solvent.

In this latter capacity water is all-important, holding in solution the solid components of the blood, contributing to form the tissues constructed by the molecular nutritive process, and again acting

as the solvent of the used-up elements of our tissues on their disintegration and definitive elimination. Moreover, there is a constant demand on the part of the animal economy to supply various excretions and secretions. The lungs eliminate during respiration, as we have seen, a considerable quantity of fluid daily. The same may be said of the skin, from which insensible perspiration is constantly carrying off vapour. Moreover, there are many glands, the lachrymal, the salivary, the intestinal, which make large demands on the system for water as the basis of their various secretions.

Water is contained in great abundance in all kinds of solid food, but in much greater proportion in vegetable than in animal substance. A great proportion of the weight of all living animals, however, is made up of water. Thus a man of 154 lbs. weight contains 116 lbs. of water, and only 38 lbs. of dry matter.

Water is thus abundantly introduced into the system whenever solid food is taken. The supply thence obtained is, however, quite insufficient for the wants of the economy—a fact which explains the universal craving for fluid. The quantity of water required by the adult human economy has been calculated at from two to three pints during the twenty-four hours, independently of that which is contained in the solid food. This amount may be considered to represent the fluid requirements in cold or temperate weather.

In warm weather the insensible cutaneous exhalation is very sensibly increased, and the craving for fluid rises with the temperature. When the heat is very great, and approaches to or exceeds that of the body, the cutaneous exhalation and the desire for fluids are both extreme. Nature adopts this means of getting rid of the superfluous heat generated by the economy, which is no longer carried off by the cool circumambient atmosphere. The vaporization of the cutaneous perspiration on the surface of the body carries off, in a latent form, the extra heat, and keeps the body at its usual temperature. Thus is explained the relief which the free perspiration of a moist skin affords in warm weather, and the uncomfortable, burning sensation which attends dryness of the cutaneous surface under similar circumstances.

It is worthy of remark that the absence of fluids is much more difficult to bear than that of solid food, so necessary is water for the vital processes. Life may be sustained for weeks without solid food, if fluid is supplied; but in the entire absence of the latter, death closes the scene in a few days. In a case of tetanic hysteria which I attended some years ago, the patient, a young lady of eighteen, was at last seized with convulsive vomiting every time she attempted to take solid food. For five weeks she apparently rejected every particle of solid food that she endeavoured to swallow, and yet remained in the full possession of her

faculties, although much emaciated. After that time the vomiting extended to fluids, which she could previously swallow in small quantities, when she sank rapidly, dying on the fourth or fifth day.

The animal creation are satisfied with water, indeed they show dislike and repugnance to all other beverages. Man alone, especially in a civilized state, seeks to combine food and nervous stimulants with his beverage. The latter may thus be divided into nutritious or stimulating.

Nutritious beverages, such as milk and soups, contain in solution the same elements of nutrition as solid food, viz., saccharine, amylaceous, fatty, oily, and nitrogenous products. The watery element is absorbed by the coats of the stomach and intestines; whilst the solid substances, held in solution, remain behind, and are submitted to the digestive process we have already described.

Stimulating beverages are either alcoholic, as spirits, wine, beer, or non-alcoholic, as tea, coffee, cocoa, mathé, coca, etc. The latter owe their stimulating powers to the presence of a peculiar element which has been extracted from tea and coffee, thein and caffein. This element produces all the stimulating effects of the containing beverages on the nervous system; it has, however, no chemical affinity with alcohol.

Alcohol is composed of carbon, hydrogen, and oxygen. The centesimal proportions are—carbon,

52·6; hydrogen, 12·9; oxygen, 34·5=100. This chemical composition points out its destination in the human economy. It is absorbed like water by the walls of the stomach and intestines, rapidly reaches the capillary vessels, stimulating in its course the liver, brain, and nervous system generally, and, if in small quantity, is in a great measure burnt, by combining with its own oxygen, and with that absorbed during respiration. Thus carbonic acid and water are formed, and heat is of course evolved. When injected in larger quantities it is in a great measure eliminated as alcohol by the kidneys, lungs, and skin. Under such circumstances pure alcohol is found in considerable quantities in the substance of the brain, and in minor quantities in that of the liver and kidneys. The first two organs seem to have an affinity for it; and thus is explained the intoxicating effects of alcohol in whatever form administered, and the tendency to chronic disease of the liver in spirit drinkers. The alcohol found in the kidneys may be merely the result of their being natural emunctories. The physiological effects of alcohol, when introduced into the system, may thus be said to be stimulation of the nervous system, organic combustion, and elimination in the shape of carbonic acid and water, with evolution of heat, and the arrest or diminution of destructive metamorphosis.

This is the view of its action on the animal economy supported by Liebig. More recent researches have proved, as stated, that alcohol is in

a great measure eliminated from the economy in a pure state. Some observers have even denied the combustion theory entirely. No doubt both views are correct. Small quantities of alcohol ingested are burnt, and thus create heat, whilst large quantities are, to a great extent, eliminated. Both modes of administration, no doubt, arrest destructive metamorphosis of tissue.

I am glad to find that this medium, or eclectic view of the question, is taken by so learned and accurate an observer as Dr. Pavy. In his "Treatise on Food and Dietetics," p. 122, *et seq.*, he says:— "Looking at the very large quantity of alcohol, under the form of various beverages, that is consumed amongst us, and consumed under the idea that it is an article capable of being turned to useful account in the system, the question before us becomes one of extensive interest and importance. Now, suppose it be conceded that evidence has been adduced sufficiently decisive to show that alcohol, after being ingested, escapes from the body through various channels, this would form all that it is contended has been discovered. Neither of the persons whose observations have been referred to (Lallemand, Perrin, Duroy, E. Smith, Parkes) has collected the alcohol, or done anything towards showing that what escapes is equivalent to that which enters . . . . . . From a review of the evidence as it at present stands, it may reasonably be inferred that there is sufficient before us to justify the conclusion that the main portion of the alcohol ingested becomes destroyed

in the system, and, if this be the case, it may be fairly assumed that the destruction is attended with oxidation and a corresponding liberation of force, unless, indeed, it should undergo metamorphosis into a principle to be temporarily retained, but nevertheless ultimately applied to force production. The subject appears to me to be open to physiological as well as chemical investigation, and probably some additional light may be hereafter thrown upon it by an approach through the former channel."

The primary result of the ingestion of alcohol, or of beverages containing alcohol, in moderate quantities is gentle stimulation. The heart's action becomes more frequent, an agreeable glow pervades the economy, and a feeling of increased strength is experienced. The thermometer, however, does not show any rise in the temperature of the body, so that the sensation of warmth must be principally a gastric or nervous one. This gentle stimulating action of alcohol in small doses certainly seems to have the power of rousing and exciting the action of the stomach, and of thereby facilitating the processes of digestion.

In larger doses alcohol, on the contrary, appears to partly paralyze the action of the stomach, to suspend and often to arrest digestion. It appears also, from direct experimentation, to reduce the temperature both in health and in fevers. This latter effect is probably produced by acting through the nervous system on the vascular system.

Even when taken in moderate doses alcohol, ac-

cording to the experiments of M. Maurice Perrin, diminishes the amount of carbonic acid evolved during respiration in the proportion of from 5 to 22 per cent., as compared with the amount evolved by the same individual during abstinence. This result implies a diminution in the activity of intra-vascular oxidation. When perpetuated, by constantly repeated large doses of alcohol, such a diminution of organic activity must be attended with noxious results to the economy.

Pure alcohol is obtained by the distillation of any fermented liquor. It first passes over with steam, and is combined with water. By redistillation in combination with various chemical agents for the absorption of water, a pure or absolute alcohol is obtained, very volatile, the specific gravity of which is ·794. Diluted with 16 per cent. of water it is rectified spirit, and is used of this strength in pharmaceutical preparations. Proof spirit contains about half its weight of water, and its specific gravity is ·920. This is the ordinary strength of the spirits consumed as brandy, gin, and whisky. When the alcoholic strength of wine is spoken of as being so much per cent. — ten, twenty, thirty — this proof spirit standard is the one meant.

Most of the older works that treat of wine give as the percentage of spirit which they contain figures much below the real ones, and I myself was misled by them in the first edition of this work. The samples of wine given for analysis to scientific men must have been always invariably adulterated,

unless absolute alcohol is meant, which is nearly double the strength of proof spirit.

That such is the case is evident, from the details given by Dr. Druitt, in his admirable work entitled "Report on Cheap Wine. Second Edition. Renshaw, 1873," which will amply repay perusal. The real facts of the case were only cleared up by the two Government reports made in 1861-62. The first was the report of an inquiry under the authority of the British Government, in the year 1861, into the strength of wine in the principal wine-growing countries of Europe. The second was a report to the Commissioners of Her Majesty's Customs of the results obtained in testing 569 samples of the various wines shown at the International Exhibition, with a general abstract of the average strength.

These wines were sent by the growers, or taken at the places of growth, and were specimens of pure, unadulterated, unfortified wines. The amount of proof spirit they contained varied from 17 to 24 per cent., exceptional specimens reaching 27 or 30.

The fact of 26 per cent. having been fixed upon by Government for the highest standard of alcoholicity in natural wine, as a result of these investigations, has led to the incontrovertible discovery that many of the wines that reach England from the Continent are fortified by the addition of spirits, to suit the English market. Such is the case with nearly all the Spanish, Portuguese, and Sicilian wines, Sherry, Port, Marsala. The usual selling standard for these fortified wines is 35 per cent. of proof

spirit, sometimes more. At the former rate each glass of Port or Sherry, or Marsala, contains nearly one-third of proof spirit, which accounts for the fiery burning impression they create in the throat of those who are not accustomed to them. It appears that we export nearly half as much spirit to Portugal, Spain, and Sicily as we take wine from these countries. This spirit, also, is not spirits of wine, but principally, if not entirely, the spirit made in England from grains, worth only about 2s. a gallon.

Wine differs from spirits in containing less alcohol and more water, vegetable acids and volatile ethers, along with a vinous extractive principle, which have a separate stimulating power over the nervous system.

The quantity of *proof* spirit contained in unfortified wines varies, as will be seen by the following table, an average from many specimens:—

	Percentage of Alcohol.
Sherry	27 to 31·7
Marsala	22
Port	23·5
Gard (South of France)	24
Hermitage	22
Burgundy	21·5
Claret	17·75
Rhine or Hock	21·9
Hungarian	21·9 (*Druitt.*)

The stimulating power of wine, therefore, is not

to be measured by the mere amount of alcohol it contains. The volatile ethers and the extractive principle participate in the stimulating influence which it exercises on the nervous system. For instance, Burgundy contains 21·5 per cent. of alcohol, whereas Claret only contains 17·75 per cent., and yet by many persons the latter is found to be fully as potent as the former. This is probably to be explained by the greater predominance of the ethers. Champagne is an artificially made wine, fortified and sweetened by the addition of alcohol and syrup; its alcoholic strength thus varies greatly.

All wines contain vegetable acids free, viz., acetic, tartaric, and racemic acids. The proportions in which they are found are considerable, as will be seen by the following table by Professor Mulder:—

	Grains in 100 grammes, or $3\frac{1}{2}$ ounces.
Hock	$8\frac{2}{5}$
Burgundy	$8\frac{3}{10}$
Madeira	$7\frac{3}{10}$
Bordeaux	$7\frac{3}{10}$
Champagne	$7\frac{3}{10}$
Lacryma Christi	7
Port	$5\frac{4}{5}$
Sauterne	$4\frac{1}{2}$

The presence of these acids is more or less apparent according to the amount of sugar which the wine contains. Thus, Sauterne, being all but completely free from sugar, has a decided acid taste,

although containing less acid than Port. This latter wine, so generally considered to be free from acidity, contains nearly two grains per ounce; but it also contains twenty grains of sugar per ounce, which obscures the acid. In Champagne the quantity of sugar is so great, that not only is its acid obscured, but sweetness is substituted.

The quantity of acid contained in the wines usually drunk in this country will be better appreciated when it is recollected that in a pint of Port there are above thirty grains of free acid; in the same quantity of Champagne, Madeira, and Claret, about forty grains; and of Hock, about fifty. In one ounce of Port there are from sixteen to thirty-four grains of sugar; of Tokay, seventy-four; of Madeira, six to twenty; of Sherry, four to eighteen (Bence Jones).

Thus the stomach of wine-drinkers is called upon to dispose not only of diluted alcohol, but also of considerable quantities of free acids, sugar, and volatile oils, which form important elements to take into consideration—especially when wine is taken in large quantities. Is it surprising that, in such cases, it should so often disturb the digestive process?

Malt liquors, generally, differ from spirits and wine in containing, in addition to alcohol, a certain proportion of saccharine substance that has not been transformed into alcohol during the process of fermentation, along with some soluble gluten derived from the grain.

By evaporation these elements can be obtained in

the shape of a solid extract, which varies in quantity from four to eight or more pounds in the hundred of the beer. The gluten being the nitrogenous element in grain, and the sugar the carbonaceous, the well-known nourishing powers of beer are evidently dependent on their presence.

The alcohol contained in beer varies according to the kind of beer examined. In the strong beers and ales of our country, the proportion of "alcohol" is generally below that of even the light Continental wines (except Claret), as will be seen by the following table (Professor Johnston):—

	Percentage of Alcohol.
Small beer	1 to $2\frac{1}{2}$
Porter	$3\frac{1}{2}$ — $5\frac{1}{2}$
Brown stout	$5\frac{1}{2}$ — $6\frac{1}{2}$
Bitter strong ales	$5\frac{1}{2}$ — 10

The percentages in this table clearly refer to pure alcohol. To bring it to proof spirit percentage we must double the figures.

In conclusion, it must be borne in mind that the various functions and processes which we have rapidly analyzed, and which conjointly contribute to the nutrition and preservation of the human economy, are all under the influence of the nervous system. It is through the influence of the brain and of the other nervous centres that the entire series of digestive and nutritive functions, as also all other functions, are carried on and efficiently

performed. Thence the health and integrity of the nervous system, and, as a result, healthy nervous influence, are indispensably requisite for healthy nutrition.

I often compare the animal organization to a house built of bricks. If they are good, applied in their proper places, and cemented with sound mortar, the house is a good one, and can defy the elements, storm, rain, frost, and even time,—for centuries. But if the bricks and the mortar are bad, and imperfectly put together, a house may be reared fair to look at, but unable to stand the test of the elements and of time. It crumbles to pieces; the mason is ever repairing it, but in vain.

So it is with the animal organization. Each meal is a brick. If the food is good and appropriate—if, the nervous system being sound, the functions of digestion and chylification are efficiently carried out, nutrition is accomplished throughout the economy in a perfect manner, and the animal economy is solidly built up, day by day, week by week, year by year. It is constructed of good materials, like the well-built house. Like it, such a structure can stand the shock of adverse influences. Conversely, if the food is bad or badly selected, too scanty or over abundant, the animal tenement or house is built up of bad materials, and succumbs at once to adverse influences.

CHAPTER II.

NUTRITION CONSIDERED GENERALLY.

In the preceding chapter we have rapidly analyzed the various changes which food undergoes, from the time that it enters the animal economy until it has fulfilled its purposes, in repairing the wear and tear of the tissues, in keeping up the animal heat, and in creating force. We are thus prepared to take a more general view of nutrition, and of the processes by which it is acccomplished.

As we have seen, the various tissues which constitute the animal economy are ever in a state of change; for change, as we have said, is the law of organic life. When the molecules, by the aggregation of which our organs are formed, have lived a certain time—probably a very limited one for most of the organic tissues—they die, are disintegrated, taken up, and eliminated, to be replaced by others. This molecular death takes place, whether the organs into the structure of which they enter are called into play or not. In addition to the slow changes inherent to organized life, we must also take into con-

sideration the other more rapid structural changes which pertain to the functional activity of organs. Every muscle that contracts, every thought that passes through the brain, every sensation that is perceived, every secretion that occurs—indeed, every organic action that is accomplished—is probably attended with the destruction of some element of the intimate organic structures that have contracted thought, been impressed, secreted, or acted.

Inasmuch as the health, vital power, and growth of an organ are promoted by the rapid succession of these molecular changes, it must become at once apparent that the exercise of any particular series of organs strengthens and invigorates them. Thus it is that general exercise developes the muscular system generally, and that the exercise of one particular set of muscles developes that set and not others; as is observed with the blacksmith or the dancer. With the first the arms, with the second the legs, attain unusual development, owing to the nutritive activity which is the result of their peculiar pursuits. Thus also it is that profound and continued study strengthens, invigorates, and enlarges the brain, increasing its nutritive and vital activity and power.

But in order that the different organs should be thus strengthened and invigorated by exercise, two conditions are necessary. First, it must not be extreme, it must not be carried so far that the vital powers are unable to repair the tissues as they are

consumed or destroyed; secondly, the elements of nutrition that are requisite to provide the materials of repair must be taken in sufficient quantity. If the destruction of tissue from use is greater than the vital power of repair, loss of substance follows. If the elements of nutrition are not duly supplied, the molecules destroyed cannot be duly replaced. In either case, the destruction or waste being greater than the renovation or repair, the organs, instead of being increased, become atrophied—diminish in bulk and power.

Thus we see that the constant but rational exercise of the muscles renders a man more muscular and vigorous; and as increased muscular vigour and power renders respiration, circulation, and all the functions of life more active, the physical frame becomes more perfect, and the health sounder and more firmly established. On the other hand, constant exercise of the brain invigorates and sharpens the intellect, and opens the mind to a world of thoughts and ideas to which the sluggish brain of the mere physical man remains inaccessible.

Throughout life, even when greatly prolonged, the same results are generally observed. The muscular man, who retains his active muscular habits up to old age, generally retains also unusual muscular vigour; whilst the intellectual man, who has vitalized, vivified his brain by brain exercise or thought, generally retains great mental powers in advanced life. We see this fact exemplified in

many existing celebrities (1858), Humboldt, Lord Lyndhurst, Lord Brougham, Sir Benjamin Brodie. We have seen it in many of the illustrious dead; Goethe died at 84, Voltaire 86, Newton 85, Buffon 81, Franklin 84, Morgagni 89, and Rogers 94.

Unfortunately, we rarely witness in the same individual a healthy frame developed by active exercise, combined with high intellectual power, the result of mental labour. Generally speaking, the muscular man, the rustic, or mere Nimrod allows his mind to lie fallow; the molecular structure of the brain substance is but slowly changed, and mental torpor and sluggishness creep over him, obscuring his mind in the mist of disuse. The student, the man of letters and thought, on the other hand, is apt to forget—to neglect exercise; for it requires time—much time—which to him is all-valuable. Time is more knowledge, more power, the means by which only he can attain the objects of his ambition. His muscles, but little used, left to their unstimulated organic changes, become weak and torpid. They promote but feebly respiration and circulation, and the activity of organic changes taking refuge in the brain, all other functions are languidly performed, and health becomes impaired, often irremediably.

The current of organic changes which constitute nutrition may, indeed, be compared to that of a river. The mountain stream, which descends precipitously from Alpine heights, is clear, transparent,

and undefiled; because the watery atoms of which it is composed succeed each other so rapidly that no stagnation, no corruption is possible. If dead leaves, stray fragments of wood, or any decayed substances, fall into it, they are hurried on, and do not contaminate its waters; it still remains the pure mountain torrent. Its sister in the plain, dragging her sluggish course through fertile prairies, with a scarcely perceptible current, is in a different condition. The leaves, the fragments of wood, the decayed substances, all but remain where they fall, and gradually decomposing contaminate the surrounding waters.

Such is life. The rapid, pure mountain stream is the organization in which all the organs, without exception, are actively exercised, in which molecular disintegration and renovation are constantly occurring, and in which, consequently, the phenomena of nutrition are taking place vigorously and healthily. In such an organization, the entire economy being healthy, if the constitution be originally good, and surrounding circumstances be favourable, the ordinary causes of disease are victoriously resisted. The lowland stagnant stream is the organization in which the nutritive changes are slowly, sluggishly accomplished, in which the phenomena of molecular nutrition are feebly carried out, and in which, consequently, all morbific agencies have full scope for their development.

From what precedes, it will be at once evident

that nutritive requirements must vary greatly with reference to age, to social occupations and position, and to climate.

During the earlier periods of life, not only has the organization to repair the wear, the waste of tissue, continually going on in the young as well as in the old, and to keep up its standard of heat, but it has also to build up the frame to the degree of development which it is destined to reach. This it does, as we have seen, by its own inherent vitality; each organ appropriating the additional nutriment it requires from the blood and gradually adding to its bulk. It is, in a great measure, to meet this great demand, on the part of the economy, for the elements of nutrition that the young have such large appetites, such a power of rapid digestion, and that they consume such large quantities of food. The young of man, and of all animals, are also ever active, ever in motion; so that the waste, from use, must be great. The current of nutritive life, with children, is thus truly a rapid one.

A remarkable and important feature in the history of nutritive growth and of nutritive repair of waste is, that as the organ grows and is repaired, it retains its primitive mould or shape. Although its molecules change, its form remains the same; the newly-added particles merely increasing the bulk in the one instance, and replacing the disintegrated molecules in the other. So thoroughly is this the

case, that all the peculiarities of the body are faithfully reproduced—even accidental ones, such as a scar or cicatrix.

A still more wonderful feature in the history of nutritive growth and of nutritive repair of waste is that the blood itself, from which the economy is built up, receives impressions, modification, from progenitors, and from disease, which it transmits during a long lifetime. Such is the case in the transmission of hereditary diseases, gout, scrofula, phthisis, syphilis; such is also the case after the existence of certain constitutional diseases, small-pox, scarlet fever, etc. These modifications are totally inscrutable and unknown in their intimate nature.

CHAPTER III.

NUTRITIVE REQUIREMENTS IN MAN CONSIDERED WITH REFERENCE TO SOCIAL OCCUPATIONS, TO TEMPERATURE, AND TO CLIMATE.

THE nutritive requirements of the human economy are ever varying according to the circumstances in which it is placed, as regards temperature, climate, and social occupations. The materials or elements of nutrition made use of by the different races of men in different climates are, indeed, so variable, that were it not for the key afforded by their chemical composition, we should vainly endeavour to reconcile them.

We now know that the frame of man is composed of oxygen, nitrogen, carbon, and hydrogen, *plus* various salts; that the oxygen is extracted from the atmosphere during respiration; that the salts are provided for him in his food without his being aware of their presence, and that, after forming a part of his economy, they are eliminated also without his cognizance. There remain, then, as elements of nutrition to be provided, nitrogen,

carbon, and hydrogen. The nitrogen is required, as we have seen, mainly to make and repair tissue, the carbon and hydrogen to create heat and force. The food of man must contain these three elements in a digestible form, or he dies—either of exhaustion from waste and non-repair of tissue; or from cold, owing to the non-generation of heat; or from both causes combined, that is, from deficient nutrition.

All mankind require nitrogenized food to repair the daily waste of tissue; but the actual requirements of those who live an active, laborious, muscular life must be much greater than those of the indolent, who take little or no exercise, and scarcely use their muscular system. Nitrogen being most abundant in animalized substances generally, the food of those on whom laborious and continued muscular exertion devolves should contain such animal substances in abundance. Practically, we find that they consume it when they can obtain it. The navvy, the dock-labourer, the sportsman, eat considerable quantities of animal food, and, what is more, digest and assimilate it. The citizen who takes little or no exercise, and females generally, when not subjected to bodily labour, require less nitrogenous food; the wear and tear of tissue being less with them. They consequently take less, as a general rule, unless actuated by the erroneous impression that in animal food lies strength, and that the more they take the stronger they will become. From falling into this error, however, they often

consume an amount of nitrogenous food which they can neither digest nor assimilate. It is the same with the indolent inhabitants of warm countries. Very little nitrogenous food suffices to repair the daily waste of an organization mostly at rest; for the mildness of the climate in which he lives greatly diminishes the necessity for constant labour which obtains under a more inclement sky.

The demand of the human economy for non-nitrogenous food, or food containing the materials required for the generation of animal heat, varies, also, considerably, according to temperature and to climate. We have seen that heat is generated, partly, by the combination of the oxygen taken up during respiration with the carbon and hydrogen of our own used-up, effete tissues, and partly by the combination of the said oxygen with the carbon and hydrogen of the food transformed into chyle by the process of digestion.

The standard heat of the human economy is from 98° to 99° Fah , and varies but little at all ages, in all climates. When the external temperature is below 98°, the body is constantly losing heat by radiation. The lower the temperature of the circumambient atmosphere, and the more the body is exposed to its contact, the greater the loss, and the greater the amount of heat that has to be generated to keep up the normal standard.

When the temperature of the surrounding atmosphere is above 98°, the generation of animal heat

must be at its lowest point, and the body, instead of being cooled by parting with heat to the atmosphere, has to get rid of that which it creates in over-abundance, and to resist the heating influence from without. This it accomplishes, as we have already stated, by the vaporization of the cutaneous perspiration. When the latter passes from the fluid to the vapour state, a considerable amount of caloric becomes latent; and as this caloric is abstracted from the body, the latter is cooled down to the normal standard. The cutaneous perspiration, under such circumstances, becomes more or less abundant, according to the requirements of the system. In tropical climates, and in temperate climates in summer, when the thermometer reaches 80° Fah., the exhalation of fluid from the skin becomes very free, especially after any exertion. At a higher temperature, at 90° or above, the body is bathed in perspiration, even without any effort, to its great relief. Absence of perspiration exposes to heat apoplexy.

I have experienced this myself in Algeria, when travelling on the more southern spurs of Mount Atlas, in immediate proximity to the desert of Sahara. A sirocco wind blowing from the desert, April 25th, raised the thermometer to 96°, nearly the heat of the blood. Although streaming with perspiration I and my companions did not suffer in the least, owing, no doubt, to the rapid evaporation of the cutaneous exudation freeing us from the superabundant heat.

As, however, it is only exceptionally that the human economy is called upon, in any climate, to bear a heat above 98° in the shade, the rule may be said to be, that we are constantly losing caloric to the surrounding atmosphere, in greater or less degree, according to its temperature, and that a very considerable portion of the food which we consume—in our climate probably four-fifths—is destined to be burnt like coal in the fire, to replace the caloric so lost, and also to generate force.

When the healthy animal economy has been exposed to a cold temperature for some time, the generation of heat by organic combustion becomes very active, and cold is borne without inconvenience. Should warm weather suddenly occur, the generation of heat still goes on for a short time nearly at the usual rate, and the heat is felt to be very oppressive and disagreeable. The economy cannot all at once adapt its organic changes to the suddenly altered requirements. By degrees, however, it ceases to create heat in such abundance, and then, being no longer oppressed by that which we ourselves generate, we feel the warmth less. Moreover, the skin becomes more and more fit to perform its new duties, and thereby to cool the heated frame.

The same series of organic changes occur conversely, and explain the apparent intensity of the first chills of autumn or winter. The economy for months has been creating but little heat, and some time must elapse before it is up to the mark—

before it has got up the steam, if we may use the expression. During that time, of course, we feel very cold and chilly.

As we have seen, the heat-generating articles of food are those which contain carbon and hydrogen in great abundance, and little or no nitrogen; such as vegetables of all kinds, amylaceous or farinaceous substances, oils, fats, alcoholic beverages. The natural instincts of man apprising him of the requirements of his economy, the colder the climate in which he lives, and the more he is exposed to atmospheric vicissitudes, the greater is his craving for heat-creating nutritive materials, in the shape of carbonaceous food. Thus it is that the Esquimaux or Laplander is impelled to consume large quantities of oil, extracted from the seal and other northern animals, by the combustion of which in the penetralia of his economy he withstands the intense cold of his hyperborean home. Deprived to a great extent as he is, by the rigour of the climate, of vegetable and farinaceous articles of food, a bountiful Providence has provided him with a substitute in the oil-laden animals which surround him. By their nitrogenous flesh they renew the wear and tear of his nitrogenous tissues, and by their oily fat they enable him to create the heat he requires.

The inhabitants of all northern climates show the same partiality to animal fats, either as fat, suet, grease, or butter; thereby merely obeying the

instinct which prompts them to seek for heat-creating articles of food. Nor is this instinct confined to the inhabitants of northern regions. In the South there is but little pasture; butter does not keep; and animal food and alcoholic beverages are but little required or consumed. Nature has, therefore, provided a substitute in the vegetable oils so abundantly supplied by the olive-tree, the palm-tree, and by other vegetable productions. The partiality evinced by the natives of southern regions for vegetable oil is evidently, in a great manner, the result of the instinct which prompts them to seek in their food the elements of combustion and of heat- and force-production. This instinctive craving for oleaginous matter, in all climates, is also connected with the physiological fact, on which more stress will be laid hereafter, that fatty matter is essential to the formation of healthy chyle.

The craving of the inhabitants of cold and temperate regions for alcoholic beverages is partly to be accounted for on the same grounds. Alcohol, being composed of carbon and hydrogen, feeds organic combustion, and thus creates heat. Alcohol, also, being directly absorbed by the walls of the stomach, very rapidly reaches the circulation and capillary system, so that the generation of heat is very prompt. Thence, probably, in a measure, the sensation of general and genial warmth which soon follows the ingestion of all stimulating beverages that contain it. Thence, also, the power shown by

the human economy in northern latitudes of bearing, without permanent injury, the habitual use of large quantities of alcohol in various forms. Thus, it is a matter of general observation, that a sportsman who in London can scarcely take a glass of whisky-and-water without suffering from headache and other disagreeable feelings, when shooting in the Highlands in Scotland, and exposed all day to the keen atmosphere and cooling breezes of this mountain region, will drink neat whiskey with pleasure and impunity. Under such circumstances the respiration is more active, the air inhaled is denser, and more oxygen is absorbed in the lungs. The alcohol ingested is therefore readily decomposed, burnt, and heat is engendered to replace that which is being constantly lost by radiation.

In a more southern climate, or when leading a more sedentary life, this extra demand not existing, the alcohol imbibed is not got rid of so easily or so effectually; it is longer retained in the circulation, and thus stimulates the brain and nervous system more powerfully. Moreover, its combustion interferes with the combustion of the disintegrated and effete tissues of the economy—a most important fact in the history of alcoholic beverages. The pernicious influence exercised on the brain and liver is thus increased by the physiological influence alcohol exercises in arresting the destructive metamorphosis of molecular tissue.

It will be remembered that the organic disinte-

gration of our tissues is followed by certain chemical changes. The nitrogenous detritus combines with part of the oxygen contained in the blood to form urea, which is eliminated by the kidneys; whilst the carbon and hydrogen, combining with another portion of the blood-oxygen, form carbonic acid and water, which are thrown off from the lungs during expiration. If alcohol is present in the blood its decomposition is so easily effected, and it combines so readily with the oxygen which the latter contains, that it appears, under ordinary circumstances, to be first burnt, and thus to interfere with the burning of the detritus of organic waste. Thence effete, used-up organic materials accumulate in the blood, which poison, as it were, the entire economy, helping to produce mental torpor and general nervous and organic disturbance. If we add to the above conditions the effect immediately produced on the brain by all alcoholic beverages taken in excess, viz., first excitement and then stupor, we shall have a complete idea of the influence which they exercise on the human economy.

These physiological facts explain the deadly effects of alcoholic beverages on the human economy in warm climates, and in temperate climates in warm weather. Their ingestion in large and frequent quantities, when the temperature is very high, must be resisted by an effort of reason, for the temptation is very great. On the one hand, the active perspiration going on from the skin induces

thirst; on the other, the effect of a high temperature is to induce a feeling of languor, of debility, which the alcoholic stimulus removes for a time. Thus, unless controlled by reason, the inducement to take constantly "brandy and soda water" *et hoc genus omne*, is all but irresistible.

I would remark that an equally cooling, soothing influence on the system is produced in very warm weather by small doses of coffee, as taken in the East. When travelling in the East, at Tunis, Smyrna, and Constantinople, with the thermometer between 80° and 90° Fahr., I found the desire for iced drinks, rendered slightly stimulating, very great. But I learnt from my dragoman that a liqueur-glassful, about two tablespoonfuls, of strong coffee, the amount usually taken at a time in the East, removes all these feelings in ten minutes, and that without any injurious effect on the system at large. Our usual dose, a teacup or breakfast-cupful of coffee, would over-stimulate.

On one occasion I travelled up the Danube by steamer, with the thermometer at 96° for forty-eight hours. The Eastern travellers all took small doses of coffee in this manner five or six times in the day, whilst the English travellers were imbibing innumerable glasses of sherry or brandy and seltzer water. The former told me that such a mode of meeting heat, and the lassitude it occasions, would soon destroy health and life in their climate, and had that result with the lower orders, when they gave

way to the temptation, as they sometimes did. Not only should the ingestion of alcoholic beverages, no longer required as heat producers, be kept within very strict bounds in warm weather, but the amount of heat-producing food should be considerably reduced. Nature points out the advisability of so doing by diminishing the appetite or desire for food; but we seldom obey her admonition, generally continuing, from habit and a wish to invigorate the system, the dietary of colder weather or climates. This, no doubt, is one reason for the frequency of biliary disorders in tropical climates, and of the general explosion of biliary derangements which we see in temperate regions in autumn, when warm weather has existed for some time.

As nitrogen, carbon, and hydrogen are found both in animal and vegetable food, man can live on either one or the other. A mixed diet, however, is evidently most conducive to his welfare, as it best enables him to meet the ever-varying demands upon his organization, for repair of waste and for the generation of heat and force.

The teeth of man prove that he is destined by Nature to be omnivorous. He has the incisor teeth (eight) of the rodents, or grain-eating animals, the canine teeth (twelve) of the carnivorous, or flesh-eating animals, and the molars (twelve) of the ruminants, or grass-eating animals. Thus, although man can live, exist, on any one of these three kinds of food, exemplified by bread, meat, and vegetables, he does

not reach his full development of health and strength unless the three are blended in his dietary, as Nature evidently intended that they should be blended.

The existence of twelve carnivorous teeth in man stamps him as a flesh-eater, and explains, to a great extent, the bloodthirstiness and cunning of his character in the non-civilized and even in the civilized state. He has a strong craving for nitrogenous or animal food, which can only be satisfied by the destruction of the animals on which he lives. These he destroys not only without remorse but with a positive feeling of pleasure and satisfaction, not only to supply his actual physical wants but for the mere pleasure of capture and destruction. In this sense civilized man himself is inferior to most carnivorous animals, which seldom take life unless propelled by hunger.

It is this natural carnivorous, life-destroying, propensity which explains the wholesale slaughter of war. The most noble and gentle-minded warrior will ensconce himself behind a wall and pick off, with his rifle, a dozen so-called enemies, and that not only without remorse but with actual delight and self-congratulation. This carnivorous instinct is so strong that religion, which tells of peace to all mankind, can scarcely curb or control its impulses.

The Esquimaux at the North Pole, and the Ranchero, or South American hunter, both live all but exclusively on animal food. But the Esquimaux feeds on animals loaded with fat or oil, which he

consumes in large quantities, that he may, by the organic combustion of its carbon and hydrogen, create the heat he requires to resist intense cold. The South American, on the contrary, who is nearly always on horseback, and leads an active, muscle-consuming life, in a warm climate, feeds on beef dried in the sun, which affords him the nitrogen he requires to repair the waste of tissue consequent on his active habits. The dried beef, from which nearly all the fat has been removed, is all but sufficient, because the temperature of the surrounding atmosphere is constantly so high that little animal heat is demanded, and the little carbon and hydrogen he consumes, either as animal or vegetable food, are principally employed in the generation of force.

The Irishman and the Hindoo can live and thrive on a dietary in a great measure vegetable—the one on potatoes and milk; the other on rice, gee, and pulse—although inhabiting very different climates. But in both countries the amount of vegetable food required to sustain life is very great, especially in the colder climate. It is found that an Irishman wants many pounds' weight of potatoes, with milk, to keep him in health. The quantity of rice consumed by the Asiatic, although less in proportion, is also very great. Potatoes and rice containing a much smaller proportion of nitrogen than wheaten flour, a much larger quantity must of course be ingested, in order that the economy should extract the necessary amount of nitrogen which it requires

to repair its waste. Thus, in both instances, the digestive system is loaded with a larger amount of carbonaceous food than is demanded for the generation of heat and force by organic combustion. Were a small amount of animal food taken, instead of the superabundant farinacea, the true wants of the economy would be much better and easier supplied.

It is also worthy of remark that the Irishman shows, like all northerners, an ardent desire to increase his heat-producing powers by the addition of alcohol to his heat-producing food, which the Asiatic does not, because he inhabits a southern region. It would seem that the carbon and hydrogen contained in the food of the former scarcely suffice for the constant generation of heat necessitated by a cold, damp atmosphere. Hence, in part, the instinctive desire for alcoholic beverages. I say in part, because the craving for alcohol, although it may have its origin in an instinctive feeling, is apt to degenerate into a habit and a vice, independently of the requirements of the economy, owing to the stimulating and pleasurable sensations which it creates.

The working of these physiological laws, by which the demand and supply of the repairing and combustible materials of nutrition are equalized, may be observed in the various grades of our own social fabric. Thus the railway workman, or navvy, and the Thames lighterman are subjected to severe and continued muscular labour, and are constantly

exposed to atmospheric vicissitudes. To meet the double expenditure of muscular strength or nitrogen, and of heat or carbon and hydrogen, they eat large quantities of meat, and drink large quantities of beer and porter, extracting the elements of muscular repair from the one, and those of heat-production and force from the other.

I was told by an eminent railway contractor, that when some of his navvies were first taken to work on French railroads, it was found that they could do in the same time double the amount of work got through by the French workmen, who lived in a much more sparing manner, and principally on bread and vegetables. The French sub-contractors were obliged, in order even partly to efface this difference, wounding to their national pride, very considerably to increase the dietary of their workmen, and more especially to nitrogenize or animalize it. By adopting this course, the French workmen very soon increased their muscular powers. The materials for greater muscular development being given, and the muscles at the same time freely exercised, the organic nutritive changes became more rapid, the muscles increased in compactness and volume, and the work-power increased in proportion.

How vast the difference between one of these large, powerful, muscular men, consuming great quantities of nitrogenous food, and burning a large amount of carbon and hydrogen, rapidly using and

rapidly repairing his economy, and the thin, wiry, Arab inhabitant of the Sahara desert, who lives principally on dates and on camel's milk! yet each takes no more food than is required by his habits and by the climate in which he lives.

I would remark that when travelling in Algeria and Tunisia I found that the dates used as food by the Arabs are not the saccharine dates we eat as a sweetmeat, but a date all but entirely farinaceous. The Spaniards, of the province of Murcia, in which date palms are abundant, live to a great extent on the flour of these non-saccharine dates, which are exposed for sale in all the market-places.

Once these fundamental physiological facts respecting nutrition are known and accepted, we are no longer guided by crude fancies, but have sound scientific data to lead us in regulating the diet of individuals and of communities. Indeed, the importance of a thorough acquaintance with these facts, both on the part of the medical profession and of the educated public, cannot be too highly estimated, as it will tend to dispel many fallacies, many erroneous ideas respecting food which have general currency. How few there are who know or bear in mind that a large proportion of the food we consume must be composed of carbon and hydrogen, and is burnt in the capillary tissues to create heat and force—just as coal is burnt in a grate—and that when food is denied the sufferer dies of cold in our climate more than of nutritive

exhaustion. How few there are who are aware that for nitrogenous food to really repair the waste of our tissues, all the various processes which constitute digestion must be fully and healthily carried out; and that the chyle, the result of these processes, if not properly elaborated, is in a great measure eliminated, thrown out of the economy.

The general impression, not only with the public, but with many members of the medical profession, appears to be that nitrogenous food and stimulants are synonymous with assimilation and strength. The undeniable fact that between the two lies a gulf, occupied by all the varied digestive processes, the imperfection of any one of which neutralizes the result—healthy nutrition—is thus overlooked. Other grievous errors also are committed through the adoption of this, the popular view of nutrition. A certain amount of nitrogenous food is required to repair the wear and tear of the tissues, but more than the amount really demanded by organic nutritive activity, so far from adding to its power and energy, becomes a positive encumbrance—an actual poison.

In infancy and youth a considerable amount of food, and especially of nitrogenous food, is required. On the one hand, the entire economy is growing, increasing in bulk and in volume; on the other, the functions of life are all rapidly performed. The brain is active, ever acquiring information, ever full of thoughts. The muscles are constantly in play;

a healthy child is ever in motion, unless asleep. Thus the tissues are constantly being worn out by use, disintegrated, and then renewed. Hence the large appetite of growing children; hence their power of digesting great quantities of food.

We also find that Nature has provided for the young of warm-blooded animals, in the earliest period of their existence, highly animalized food in the shape of milk. Milk, in many respects, is very similar to the blood. Its nitrogen is represented by the albumen and casein (cheese), its carbon and hydrogen by the cream or butter. Thus milk contains within itself all the elements of nutrition; the nitrogenous elements for growth and repair of tissue, the carbonaceous for the generation of heat by organic combustion. Oviparous animals live on the contents of the egg in the first stage of their existence, which, like milk, contains within itself all the elements necessary for nutrition. In the egg, the white or albumen represents the nitrogenous element; the yolk, the oily or carbonaceous.

When the growth of the body is completed, and the repair of waste, along with the generation of heat and force, have alone to be provided for, the appetite in health, if not pampered or viciously indulged, may be looked upon as the test of the economy's food-requirements.

The food-requirements of adult human beings vary, as we have seen, according to climate and temperature, and according to the activity of their

organs; they also vary according to individual peculiarities. Some persons, even in health, digest rapidly and imperfectly the food which they consume. With them a considerable amount of it passes away undigested through the intestinal canal, and escapes with the fæces. With them, therefore, the fæces, instead of being moderate in quantity, and merely containing the indigestible fibrous or ligneous tissue, epithelial scales, etc., are voluminous, and contain also farinaceous granules and muscular fibres unchanged, the result of the incomplete digestion of vegetable and animal food. With persons so constituted, hunger soon returns, owing to the demands of the economy having been imperfectly supplied, and a fresh supply of food is required. It is as if part of the coal placed on a fire had fallen through the grate. With others, on the contrary, the process of digestion is slow, and the elaboration of the nutritive materials contained in the food is more complete. Such persons both require less food, and that food less frequently, inasmuch as they extract more nourishment from what they take.

Such being the case, it is evidently altogether impossible to lay down generally and *à priori* the amount of food that is required for the nutrition of individuals. The person who is protected against cold and atmospheric vicissitudes by warm clothing and a well-heated dwelling, and who takes little or no exercise, cannot, certainly, require the same

amount of food—that is, of heat-generating, tissue-repairing material—as the one who is constantly exposed to atmospheric influences, and who is constantly engaged in occupations requiring muscular exertion. Between these two extremes there are infinite gradations of social position, habits, and occupations, modifying the real food-requirements of the organization. Superadded to these considerations we have the individual peculiarities above described.

When dealing with masses, each placed in the same social hygienic position, as soldiers, sailors, the inmates of workhouses, and all aggregations of people living together, it becomes possible to establish a dietary in which the quantity of food required is determined. We must bear in mind, however, that even in these cases, the quantities arrived at are merely true of the aggregate, and not of each individual that composes it. They are media obtained by acting on numbers. In such aggregations of individuals, some require more than the allowance, some less; but by barter or by gift the equilibrium is attained. Moreover, under such circumstances, the social and hygienic condition, the amount of exposure and muscular exertion, are pretty nearly the same for all.

For some years after the growth in height has been completed, the organs of which the human economy is composed continue to increase in bulk and in compactness; in a word, to become more

perfect. The epoch of perfect development of the organization may be said to be attained by women at twenty-two or three, by men at twenty-four or five. For ten or twelve years after that nutrition is in its full vigour, and thoroughly keeps up the integrity and energy of the organic structures. From thirty-five to forty it begins to flag, and the first appearances of decay or of want of nutritive power show themselves. The muscles, not being fully repaired, lose a little of their volume and power, and collapse; thence the wrinkles that begin to form in the skin, and which are more especially visible in the face, the skin of which is lined by subcutaneous muscles. Such is the origin of the "crow's feet," that form at the outer commissure of the eyes; often the first sad sign of departing youth. Such is the origin also of the lines and furrows that take the place of youth's dimples round the mouth.

All mankind would become thin and spare at this epoch of existence were it not for a compensating fact. As a result, probably, of the diminished nutritive energy which we are describing, the carbonaceous elements of food are not entirely burnt by the oxygen of respiration, or eliminated by the liver, and fat is deposited in the laminæ of the cellular tissue, where it remains, it is presumed, in a state of organic inactivity. This deposit of fat takes place all over the body, but more especially under the skin of the abdomen, hips, and neck. It stretches the yielding skin, and thus conceals the

ravages of time, the results of diminishing nutritive power. To many women this change constitutes a second youth, and may even impart to them a charm and loveliness which they never presented in their earlier age.

The comeliness thus produced, however, like "all that is bright," soon fades. The deposit of fat often continues; especially when the tendency is constitutional, or the diet liberal, and the habits of life indolent. In such cases it may increase by degrees, until the abdomen becomes protuberant, the hips massive, and until the chin, neck, and shoulders blend into one. Then, indeed, not only has youth fled, but the grace and dignity of middle age has also departed. The adipose tendency may be arrested, no doubt, by exercise on the one hand, and by restraint in the quantity of food taken on the other; but how few there are who will acquiesce in such discipline! At this epoch of life other evidences of diminished nutritive activity appear. Gouty and rheumatic disease shows itself, indicative of languid capillary circulation, and of deficient elimination or combustion of effete organic detritus; atheromatous deposits often take place in the arteries, the result of defective nutrition; and the veins frequently become weak, and subject to varicose enlargement. Later, as age advances, the nutritive power flags, and the decay is probably general; that is, takes place in all the various functions which constitute nutrition. Both the power of transform-

ing and of elaborating food into chyle, and the organic and vital power of extracting the elements of repair from the blood, diminish in activity. Thence, although the aged often take as much food as the adult, they become thin, and waste in volume. In those in whom the tendency to the deposit of fat persists in old age, the waste of the organs is concealed by the layers of adipose substance which are formed underneath the skin, and which surround all the organs; but the shrinking and wasting of the muscles and of the other organs is not the less real, as I have often found in making post-mortem examinations of very fat elderly people.

As a necessary result of diminished digestive vitality, organic combustion languishes. Hence the chilliness of the aged, increased by the greater slowness of their circulation. The blood, circulating less rapidly through the lungs and the body generally, is less charged with oxygen; and the elements of combustion being less abundant, organic combustion takes place less rapidly, and less heat is generated. Thus is explained the cold hands and feet of the aged, and the necessity for artificial heat and warm clothing. Thence it is that the old man seeks the sun, and that we find him in the country sitting at his door for hours basking in the sun, seeking from its genial rays the warmth which the organic processes no longer afford, as in former days—the days of his youth and of his organic vigour.

As the current of human existence runs on, all these evidences of deficient nutritive power increase, and to them is often added the fatty degeneration of important organs; by which, if extreme, the thread of life may be brought to a close. The muscular powerlessness of old age is owing partly to diminished volume of the muscles, partly to the replacement of non-repaired muscular fibre by fat, and partly to weakened circulation and innervation. The loss of nervous power, and the weakening of the memory and of the intellect of the aged, is often attributable to fatty transformation. The wear and tear of the nervous substance of the brain is not effectually repaired, fat takes its place, and the powers of the nervous centre are for ever obscured.

At last nutrition ceases, and death ensues. The vital spark no longer vivifies the human clay, and its complex machinery is hushed for ever. Organic repair has been brought abruptly to a close, the human fire is quenched, and heat no longer being generated, the body rapidly loses its caloric to the surrounding atmosphere; until, after a few hours, the marble cold of death has seized upon the tenement so long the abode of the organic processes we have described.

With those, however, who leave progeny, nutritive death can hardly be said to take place; their vitality survives in their children. The vital nutritive force which gradually built up the parent

organization, repaired its waste, and enabled it to resist the destructive influences by which it was surrounded, is transferred in all its pristine vigour and freshness to its offspring. The latter grow and flourish, as the parents decay and perish.

As with the animal, so with the vegetable world; all organized creations contain the seeds of death from the first. In all, the nutritive force for a time is vigorous and energetic; powerful to produce and keep up the organized structure. In all, after a certain lapse of time, when reproduction has been accomplished, the vital power becomes less and less energetic. Finally, when decay has stamped its impress on the organization, has destroyed both beauty and usefulness, the nutritive force expires, and death ensues. Thus space is made on the earth for the young, who unite the attributes which their parents have lost—beauty and power. Thus it is that the earth remains ever young and ever fair;—youthful and vigorous organizations ever replacing those which have fallen into decay and perished, through the weakening and final arrest of the original nutritive force.

CHAPTER IV.

NUTRITION IN ANIMALS.

NUTRITION in animals follows precisely the same law as in man, with slight differences, deduced principally from the fact that man is omnivorous, whereas by far the larger proportion of animals are either frugivorous, herbivorous, or carnivorous. That man is destined to live on a mixed dietary, partly animal, partly vegetable, is shown by his teeth, as we have seen, p. 68. Some resemble the teeth of the rodent or frugivorous animals, some those of the herbivorous, and some those of the carnivorous. It is also shown by his intestinal canal, which occupies a medium position, being neither as long nor as complex as that of herbivorous animals, nor as short as that of the carnivorous.

Frugivorous and herbivorous animals find in the grains and in the grasses which they consume the chemical elements of nutrition, required for the nutritive growth and repair of their organization—viz., carbon, nitrogen, and hydrogen, oxygen

and salts; the oxygen, as with man, being principally furnished by the atmosphere during respiration. Nitrogen is present in grain and in grasses, and from it are the albumen and fibrin of the organic tissues generated. The carbon and hydrogen, which form the principal bulk of the vegetable food of the herbivora, are, on the one hand, converted into fat by the nutritive process, and on the other, are burnt in creating animal heat and force, as in man.

From these facts we might conclude that, for herbivorous animals to thrive and do well, a large amount of vegetable food must be consumed. And such is really the case, herbivorous animals requiring a large bulk and weight of the substances on which they live, in order that they may find in it enough nitrogen to form their often huge frames, and enough carbon and hydrogen to produce, by its combustion, the heat they require to make good the constant loss from exposure to atmospheric influences. The generation of heat and force, from organic combustion, must, indeed, be very great, when we consider how well they bear exposure to cold, night and day, in all climates, often during very rigorous weather, and the amount of force they expend.

Carnivorous animals find the elements of nutrition already elaborated and prepared for them in the flesh and fat of their victims. Consequently a less complex and shorter intestinal tube answers all the

purposes of digestion. They have, as it were, merely to divide, macerate, and dissolve the nitrogenous and carbonaceous tissues which they ingest, and to rearrange them in their own economy, by the mysterious function of assimilation and of organic nutrition.

NUTRITION IN PLANTS.

Nutrition in plants differs from nutrition in animals in the leading fact, that whereas the food of animals is principally derived from the organic world, that of plants is solely derived from the inorganic world.

All vegetable substances live and increase on food extracted from the soil or from the atmosphere, which their vital force enables them to decompose, if necessary, and to assimilate.

Plants, like animals, are formed of the elementary gases, hydrogen, oxygen, and nitrogen, of carbon, of sulphur, of phosphorus, and of other inorganic elements, and salts.

By far the greater part of their bulk, however, is formed of carbon, which constitutes one-half of their weight in the dry state. It is entirely extracted from the atmosphere, the carbonic acid of which is absorbed by the leaves, the carbon retained, and the oxygen in great part emitted. It was formerly supposed that a great part of the carbon of plants was extracted from the soil by the roots, but it is now generally admitted that in green-leaved plants

nearly the whole of the carbon is taken from the atmosphere.

For carbon to be thus extracted from the atmosphere and used in the formation of the plant, two conditions are all but essential—viz., green (chlorophyll holding) tissue in its leaves or branches, and light. The stronger the light, the more active is the carbon-extracting nutritive function.

The proportion of the other principal elementary components of vegetable substances, according to Professor Johnston, "Agricultural Chemistry," are—

Oxygen rather more than one-third.
Hydrogen little more than 5 per cent.
Nitrogen from ½ to 4 per cent.
Sulphur 1 to 5 per cent.
Phosphorus about a thousandth part.

The following table, from the same source, gives a very clear idea of the proportions in which Nitrogen, Hydrogen, Oxygen, Carbon, and residual ash enter into the composition of the principal vegetable substances used as food. The figures apply to 1,000 lbs. of such substances, perfectly dry:—

	Nitr.	Hydr.	Oxy.	Carb.	Ash.
Wheat . . .	23	58	434	461	24
Oats	22	64	367	507	40
Red Clover Hay	21	50	378	474	77
Hay	15	50	387	458	90
Potatoes . . .	15	58	447	440	40
Oat Straw . .	4	54	390	501	51
Wheat Straw .	3½	53	389	484½	70

The oxygen is partly derived directly from the atmosphere, and partly from the decomposition of water, taken up by the roots, which also furnishes hydrogen. The nitrogen which plants contain, as in animals, is not supposed to be extracted directly from the atmosphere, but from nitrates and ammonia salts, or from other soluble substances containing nitric acid, and taken up from the soil.

The sulphur, phosphorus, alkalies, lime, magnesia, chlorine, silicon, and iron which plants contain, and which remain in the ash after combustion, are taken up directly from the soil by the roots.

The small proportionate amount of the ashes which remain after combustion is no criterion as to their importance. They are absolutely necessary to the health, nay existence, of plants, and vary much in amount in different plants, as shown by the table.

In some of the lowest forms of animal life the distinction between the animal and the plant becomes difficult, for both plants and animals contain ternary hydrocarbons, and quaternary azotized albuminoids. When structural conditions are scarcely sufficient to guide us, the mode of nutrition becomes one of the chief distinctive characteristics between them.

In plants, the ternary principles, the hydrocarbons (Oxygen, Hydrogen, Carbon) constitute the tissues themselves, are their intrinsical and fundamental components; whereas the quaternary or azotized principles may be considered deposits, incrustations.

In animals it is just the contrary; their tissues

are essentially composed of quaternary or albuminoid principles (Oxygen, Hydrogen, Carbon, and Nitrogen), and the ternary principles form fatty deposits, pigments, when they are not in the circulation.

Plants perform a double part on the surface of the globe. First, by absorbing carbonic acid from the atmosphere, and fixing its carbon, whilst emitting its oxygen, they purify the atmosphere, contaminated by the respiration of animals and by combustion. Were it not for this agency of vegetable life, the atmosphere which surrounds the globe would probably, in the course of time, cease to be respirable both by men and by animals.

Secondly, they elaborate and prepare, in their own organizations, the elementary substances of the inorganic world, so as to render them fit to become the food of the animal creation. Such an intermediary is necessary, because animals are not organized to extract the elements of nutrition, or food, with the exception of oxygen, directly from inorganic matter.

It is also to the vegetable world that the earth owes its beauty, its surpassing loveliness. Were it not for the plants which clothe it in verdure, the earth would be a barren rock, a mere cinder, a mass of scoriæ, such as our cold satellite, the atmosphereless moon, is supposed to be at the present day.

CHAPTER V.

DEFECTIVE NUTRITION.

NUTRITION may be defective, from :—

I. Deficient vital nutritive power.

II. From the existence of acute disease.

III. From imperfect digestion and assimilation; that is, from the imperfect performance of the processes which are concerned in the transformation of food.

I.—DEFECTIVE NUTRITION FROM DEFICIENT VITAL POWER.

The transformation of food into chyle and tissue, and the creation of animal heat and force by organic combustion, are vital functions which take place under the influence of the vital power transmitted by the parent to the offspring. If the parents are young and healthy, their nutritive power is vigorous, and in their offspring it will also, under favourable circumstances, be equally vigorous. Nutrition in the latter, therefore, will be perfectly performed, and a sound and healthy organization will be

gradually created. It will have perfect vital power to repair wear and tear, to create heat by the combustion of food, to produce the force expended, to resist the influence of perturbing causes, and to carry on with vigour the functions of life during the span allotted to the human race.

If, on the contrary, the parents, one or both, are themselves deficient in nutritive energy, or are weakened, debilitated by disease or by age, they endow their offspring with the fatal gift of their own defective vital energy. In such offspring the nutritive force being constitutionally defective, it has not the power to form a strong and vigorous organization. The individual grows up small, puny in stature and development, wanting muscular strength and energy, and often, but not always, mentally deficient. The nutritive force may, in some cases, *at first* appear vigorous, and apparently form a healthy organization, but it flags and succumbs long before the period of its natural decay; and the death of the organization follows.

In either of the above instances, nutrition may take a morbid direction, the result of the taint or weakness transmitted from the progenitors. When this occurs, some morbid nutritive deposit, such as the tubercular or caseous formations of scrofula or consumption, may be generated, and threaten or destroy life; or acute or chronic inflammatory diseases may supervene, and occasion the death of the individual.

This law, indeed, holds good throughout the entire animal creation. The vital nutritive force may be originally deficient in power from the first, owing to its deficiency in the parents; and when such is the case, as a sequence, nutritive growth and formation are defective. This may even be the case although all the functions of digestion are satisfactorily carried out. Food may be properly digested and transformed into chyle, but either the tissues have not the inherent vital power of efficiently selecting and transforming into their substance the elements presented to them, or morbid products are formed. This species of defective nutrition is known by its results—an imperfectly formed and imperfectly renovated economy, the formation of diseased structures, or the death of the individual from apparently trivial causes.

In a medical sense, Nature is regardless of individual life, but protects in every possible way the integrity and continuity of the species. All individuals who physically fall below the standard of normal healthy development are relentlessly removed, in themselves or in their children—to purify the race. On the other hand, the preservation and continuation of the race is provided for in the most stringent manner, being placed under the safeguard of the strongest of all passions, self-love and the sexual instinct.

Thus it is that Providence secures the perpetuation of the human species in the full vigour and

integrity of healthy development. Such a perpetuation is intrusted to the young, to the strong, and to the healthy, whose progeny are born with the seeds of life and health: the earth is to them and to their descendants. The diseased and the aged merely prolong their own existence in that of their progeny for a limited space of time. They cannot endow them with the nutritive force which they do not possess, or which they have lost. Thus, their children are born with the seeds of disease and death in them: the earth is not to them, nor to their descendants.

II.—DEFECTIVE NUTRITION FROM THE EXISTENCE OF ACUTE DISEASE.

In acute disease the functions of nutrition are partially suspended, the digestive powers are weakened, or even for a time arrested; hence the loss of appetite, or even the absolute loathing of food which ensues. The digestive organs being unable to transform and elaborate food, an all-wise Providence preserves them from the labour they are unequal to perform, by destroying the desire for nutriment, and rapid emaciation follows, the more rapid, the more complete the inability to digest food. The process of organic destruction or disintegration inseparable from the use of our organs, and itself a condition of life, goes on, accelerated,

perhaps by the disease; but the materials to repair the loss not being afforded to the organization, it wastes in volume. Moreover, as the materials of organic combustion for the generation of heat are not elaborated by the digestive organs, the economy is obliged to reabsorb and consume its own fat—deposited, no doubt, in the cellular tissue partly as a kind of reserve tissue. Thus it is that after an acute illness of two or three weeks, the emaciation is often extreme, more especially when from the nature of the illness it has been impossible for the patient to digest any kind of food.

In continued fevers, in which the inability to take and to digest food is all but complete, and which may last for weeks, it is often found absolutely necessary to give wine or other alcoholic beverages, in order to afford to the organization the elements for heat-generation or organic combustion, and to retard the process of destructive metamorphosis of tissue. In the absence of such aid, the extremities, and then the body, gradually become colder, until death ensues, as much from cold as from starvation. In this case the human fire simply goes out for want of fuel; like a coal or wood fire that has exhausted all the materials of which it is composed, and which expires for want of their renewal.

In these cases, however, it is not physiological to rely on alcoholic beverages for sustaining life, to the entire exclusion of carbonaceous and nitro-

genous food. The former do not afford to the economy the chemical elements of tissue repair. It has always been my practice to give large quantities of milk, the simplest of all foods, at regular intervals, say about four times in the twenty-four hours, and to look upon alcoholic stimulants rather as "adjuvantia." A considerable portion of the milk administered is thrown out of the system, eliminated, by the bowels, liver, and kidneys, without aiding in the repair of the wasting tissues, but some is, no doubt, turned to good account, and that in the worst forms of febrile disease. Under this dietetic treatment the emaciation is less, and the subsequent convalescence more speedy.

III.—DEFECTIVE NUTRITION FROM IMPERFECT DIGESTION AND ASSIMILATION.

The conditions which may render nutrition defective, independently of hereditary taint and of the presence of acute disease, in connection with imperfect digestion and assimilation, are numerous. We may more especially mention:

An insufficient supply of food calculated to minister to the wants of the economy.

The abuse of alcoholic beverages.

An over-supply of food.

The sympathetic reaction on the stomach and on

digestion of chronic disease situated in other parts of the economy; and functional derangement or disease of the digestive organs.

Defective Nutrition from an Insufficient Supply of Food.—The results which follow a deficiency in the amount of food ingested differ according as the deficiency bears on the nitrogenous or waste-repairing, or on the carbonaceous or heat and force-producing food element—or on both at the same time, as is usually the case.

If the nitrogenous element is deficient, the carbonaceous being abundant, the muscular and organic tissues are not properly repaired, for want of materials, and the individual becomes weak and liable to diseases of debility; and that although fat may be developed, and although he may remain apparently in good condition, retaining the outward appearance of health.

If the carbonaceous element is deficient, the nitrogenous being duly supplied, the materials of combustion not being afforded in sufficient quantity, chilliness and the sensation of cold is experienced. Moreover, the fat deposited in the various tissues and organs of the economy being sought out, and burnt to supply the deficiency of carbon, emaciation ensues.

The deficiency of one of the carbonaceous nutritive materials, the oleaginous, is attended with other pernicious results. It is now generally admitted that oleaginous or fatty matter is absolutely required for the perfect and healthy elabora-

tion of chyle. Throughout the lacteal system, but more especially in the lacteals which traverse the intestinal walls, the albumen in solution is found in intimate union with oily matter. It seems to be combined with the extremely minute chyle-molecules. Observation appears to show that, for want of a due supply of this oily matter, the organic changes which the chyle has to pass through are imperfect, that nutrition suffers, and that disease, especially tubercular and scrofulous disease, is apt to supervene. On this physiological fact is founded the administration of cod-liver oil, in scrofula and in pulmonary consumption, both as a curative and as a preventive agent. These important facts respecting the primary nutritive processes were fully elucidated by the late Professor Bennett, of Edinburgh, in his work on Cod-liver Oil, published in 1841.

The craving for oily matter is certainly one of the universal instincts of the human race, and is indulged in more or less in all climates. In the northern latitudes animal oils are principally consumed, in southern latitudes vegetable oils are in more request. It is probably one of the reasons of the craving of children in our climate for butter, which presents oily matter to the digestion in an easily assimilable form, and is evidently a valuable dietetic agent.

It is worthy of remark that the inhabitants of Iceland, although living in a most unhygienic state, filthy in person and habits, and cooped up in badly

ventilated huts, are said to be all but free from consumption and from other forms of tubercular disease. This fact is not improbably connected with their great consumption of oil as an article of diet.

If the insufficiency of food bears both on the nitrogenous and on the carbonaceous element, the equilibrium between waste and repair is speedily lost, disintegration takes place more rapidly than reconstruction, for want of materials, and the body rapidly diminishes in volume. The rapidity with which the body thus wastes depends on the degree to which the food-deficiency extends, and on the circumstances in which the individual is placed, with reference to exertion, to organic expenditure, and to temperature. As the animal heat must be maintained by organic combustion, the greater the cold, the more speedy the emaciation, owing to the more rapid absorption of the fat dispersed throughout the economy. Thence it is, that in fevers and other maladies, in which the disease is prolonged for a considerable time, whilst but little food is taken into the economy, and that little imperfectly or not at all elaborated, emaciation is generally extreme when death ensues. Deprived of nutritive materials, the body has actually consumed itself.

A given amount of nitrogenous food may be quite sufficient to supply the waste of tissues during inaction, but insufficient if muscular exertion be superadded. Unless the nitrogenous food be, therefore, increased, defective nutritive repair and loss

of substance will ensue. This we see daily with horses. Whilst at rest one or two feeds of corn will keep them in condition; but at work we are obliged to give them four or five feeds, or they lose flesh and become emaciated.

In the same way a given amount of carbonaceous food may be quite sufficient to keep up the animal heat, if the individual is not exposed to atmospheric changes, if he is warmly clad, and lives in warm rooms. But if the same person is, on the contrary, exposed to cold and to atmospheric vicissitudes, if he is lightly clad, and has to resist these agencies without the assistance of artificial heat, he requires more carbonaceous food, viz., farinacea, fats, alcohol. If he does not obtain it, as occurred to our soldiers in the Crimea, heat is not generated in sufficient quantity in the capillaries; the extremities become cold, and if the exposure is continued they are easily frost-bitten. Thence the lamentable frequency of frozen extremities, *gelatio*, among our ill-clothed, half-fed soldiers. Their food was insufficient in quantity, and deficient in the elements of nutritive repair and of organic combustion; so that it neither renewed the waste of tissue, nor afforded the necessary heat-generating materials.

In the higher classes of civilized society, artificial warmth and additional clothing are principally relied on to meet the additional requirements of the body in cold weather, and but little change is required or is made in the dietary. The working classes,

on the contrary, exposed by their avocations to the weather, generally endeavour to augment their powers of generating heat, by increasing the quantity of alcoholic stimulants, and by additional food.

Thus we see that the dram-drinking propensity of these classes in northern and even temperate latitudes is merely the exaggeration of an instinctive want of the economy. This undeniable fact in physiology shows how vain is the endeavour to entirely eradicate the taste for stimulants in northern climates. All that the most sanguine can hope to effect is to prevent its degenerating into a national vice.

The ingestion of alcoholic stimulants of all kinds is attended with a feeling of temporary strength, and with pleasurable sensations, which may be partly attributed to the genial warmth that they occasion all over the body, and partly to their direct stimulation of the nervous system. The natural tendency, therefore, with those who use them, if uncontrolled by reason and principle, is to recur to them again and again as a source of physical strength, of temporary warmth, and of mental pleasure and solace.

Thus it is that a soul and body-destroying vice may be contracted and cherished until it bears down all opposition; and until, through the ruin of the digestive and nutritive system, it brings on premature disease and death.

Defective Nutrition from the Abuse of Alcoholic Beverages.—We have already briefly described (p. 66) the mode in which alcoholic beverages, taken in excess, impair digestion and nutrition.

As we have seen, alcoholic stimulants, in the shape of beer, wine, spirits, etc., may be ingested, in moderation, with positive advantage, especially in northern and temperate latitudes, by the healthy members of the community. By their stimulating influence on the nervous system of the stomach and intestines, they increase and promote the powers of digestion; by the presence in the blood of the hydro-carbon of the alcohol, elements for heat-generation are provided without the necessity of loading the stomach with as much hydro-carbonaceous food as would otherwise be required; and by their influence in retarding the destructive metamorphosis of tissue, they diminish the amount of food required.

Moreover, the stimulus afforded to the general nervous system satisfies a craving for nervous stimulation, which all mankind exhibits at the adult period of life, and which may really be considered an instinct. In northern latitudes this instinct is gratified by the alcoholic, stimulating beverages in general use; whilst in tropical climates, where their heat-generating properties are not required, the craving is satisfied by the non-alcoholic stimulants, coffee, tea, mathé, tobacco, opium, etc.

The fact is singular, but undeniable. There is

scarcely a race or tribe under the sun that does not resort instinctively to some nervous stimulant, whereas the animal creation show no such taste—no such instinct. The cause is probably to be sought for in the much greater use made by man than by brutes of the nervous centres, and in the consequent greater exhaustion of nervous force. There can be no doubt that these agents, when taken in moderation, have the power of repairing the nervous energies, and we thus find that, throughout the world, the abstinence from one is made up by the use of another. In our own climate, for instance, those who abstain entirely from alcoholic beverages, all but invariably fall back, with avidity, on coffee and tea, which supply them with the nervous stimulant they require.

A large proportion of the alcohol ingested after passing into the circulation, is eliminated, thrown out of the economy by the natural emunctories, the kidneys, the lungs, and the skin. Distillation proves its existence in the urine, in which it appears soon after its ingestion; final elimination, however, not taking place for many hours. The same remark may be made as to the duration of the elimination by the skin and lungs.

The constant irritation produced by alcohol passing through the structure of the liver and kidneys will account for the chronic inflammatory diseases of these organs, so common in confirmed drinkers.

When alcoholic beverages are taken in excess

by healthy persons, and often when they are taken in moderation by persons suffering from disease or from disturbance of the digestive organs, the stimulating effect produced on the stomach is injurious, and the function of digestion is, consequently, improperly performed. The result is the formation of imperfectly elaborated chyle, unfit for the purposes of organic reconstruction.

The most general evidence of perturbation of the digestion caused by alcoholic beverages, is the presence in the urine of one in whom it is usually healthy, *a few hours after the ingestion of food*, of uric acid, urate of ammonia and soda, and of other morbid salts, such as oxalate of lime. This is constantly found to be the case by perfectly healthy persons, whose urine is usually clear, the morning after dining with friends and taking more wine, or stimulants, and more food than they are accustomed to take—more than suits their constitution. The urine passed over night is found turbid the next morning. The disturbance of the digestion, and of the urinary secretion, is often attributed to mixing wines. This is an error; it is the increased quantity that in reality does the mischief.

Uric acid and oxalate of lime require the microscope to be detected, but urate of ammonia and soda is readily distinguished, from its being precipitated by urine as it cools, which it renders turbid. The kidneys eliminate the imperfect nitrogenous chyle in this form, and thus accomplish one of their most

important functions, that of emunctories to which is principally intrusted the duty of removing from the circulating fluid effete unassimilable nutritive elements. The imperfect chyle is refused, as it were, by the structures it was intended to repair, and is elaborated and thrown out by the kidneys as noxious matter.

The over-stimulation of the digestive organs by alcoholic stimulants is often followed by irritation of the mucous membrane of the stomach, as is shown by the dry, hot state of the tongue the day after the excess. The tongue, it is well known, faithfully indicates the condition of the stomachal mucous membrane.

It does not appear that the amount of urea excreted after the ingestion of alcohol is much increased, not more so than would be consistent with a slightly increased activity of the secretion. The presence, therefore, of urate of ammonia or of uric acid is, in all probability, principally connected with disturbed digestion, with the imperfect chylification of the nitrogenous food simultaneously ingested.

The presence of alcohol in the circulation—for, as we have stated, it is directly absorbed as such by the blood-vessels of the stomach and bowels—is attended with important organic results. The vessels that principally absorb it are the portal veins, which ramify in the stomach and intestines. By their reunion they soon form the portal vein,

which at once takes the alcohol-charged blood to the liver; and it is only after having passed through the capillary circulation of that organ, that it is poured into the general circulation.

Thus, after the stomach, the liver is the organ which most directly receives the influence of the alcohol ingested. Is it surprising, therefore, to find the liver often diseased in spirit-drinkers? The malady termed cirrhosis of the liver is generally thus produced. Irritation is set up in the substance of the organ, lymph is effused between the lobules, which becomes organized and forms fibrous bands. These bands compress and partially obliterate the proper tissue which they surround, and thus produce partial or general atrophy of the liver. The passage of the portal blood through the organ being thereby impeded, serous or dropsical effusion takes place in the abdominal cavity, accompanied, in the course of time, by a complete break-down of the general health.

The physiological influence of alcohol on the brain and nervous system is still more marked than that on the liver. When large doses of alcohol are ingested by animals and they are killed, the brain is found to be saturated with the spirit. It can be eliminated from its tissue by distillation. Thus Dr. Maurice Perrin ("Diction. Encyclop.," vol. ii.) states that thirteen ounces of the brain-tissue ot dogs, killed during alcoholic intoxication, triturated with seven ounces of water, and submitted to

distillation, gave nearly a drachm of alcohol. The same quantity of the blood submitted to the same experiment gave rather less. In many post-mortem examinations after death, during intoxication, the odour of alcohol exhaled by the brain-tissue has been noticed.

The experiments of Dr. Perrin corroborate the researches of Dr. Marcet, first published in 1860 and in 1862. (*Med. Times*, *Med.-Chir. Rev.*)

Thus is fully explained the nervous symptoms produced by the ingestion of alcoholic beverages, from simple nervous excitement to complete intoxication. Thus is also explained the more durable modifications of the brain functions which occur in the long run from the continued ingestion of alcohol in excess, as regards individual constitutions. The various dynamic perturbations, trembling, paralysis, different forms of mania (delirium tremens), hallucinations, weakening of the intellectual faculties. are probably connected with permanent changes produced in the tissues of the nervous centre.

When alcohol in excess has entered the general current of circulation, as already stated, its ready combination with the oxygen of the blood interferes with the functions which the blood-oxygen has to perform, viz., its combination with nitrogen to constitute the protein compounds which form the tissues, and its combination with the carbon and hydrogen of effete tissues and of the food, which it thus burns and eliminates from the economy. It thus exercises

a direct influence in retarding molecular disintegration or the destructive metamorphosis of tissue. The consequence is, that the blood becomes loaded with effete nutritive elements, the result of imperfect chylification and nutrition, and of the non-elimination of the products of the vital disintegration of the tissues, among which *materies morbi* carbon occupies a prominent rank. The liver and skin, also emunctories for carbon, come to the assistance of the lungs; but in vain do they endeavour to purify the foul carbon-loaded blood, if the contamination is constantly renewed.

A series of recent experiments, carefully made by the same physician, Dr. Perrin, and frequently repeated, prove that such is the case, that the ingestion of alcohol, in any shape, diminishes notably the amount of carbonic acid exhaled, no doubt by interfering with the destructive metamorphosis of tissue, that is, with an important phase of nutrition.

When alcohol, in moderate quantity only, is taken as an addition to a rational dietary, and the economy is left to its own powers, in the absence of disease and under favourable circumstances, the lungs, the liver, the kidneys, and the skin—the great purifiers of the blood—restore it, by degrees, to a state of purity. Indeed, this is what occurs in those who merely commit a temporary alcoholic excess. In the course of a few days the blood is purified, local irritation subsides, and all returns to a natural state.

But in the confirmed drinker, or in the individual who takes stimulants when, from digestive weakness or disease, or from other causes, they are decidedly prejudicial, the economy has not a chance. The organs enumerated, and especially the lungs, the liver, and kidneys, make vain efforts to purify the blood. Their efforts are constantly nullified by a fresh invasion of hydro-carbon, in the shape of beer, wine, or spirits; and these organs at last either become themselves the seat of actual disease, or suffer secondarily, from the inroads of disease in other parts of the economy.

From what precedes it will be seen that it is by no means necessary that alcoholic stimulants be ingested in large quantities to do mischief, or, to use the phrase already employed, to be taken in excess. If stimulants in any quantity, however small, interfere with the digestive and nutritive functions, they may be said to be taken in excess.

Clinical experience has led me to the conclusion that they do so interfere whenever the digestion is sufficiently disturbed for the urine to be subsequently loaded with morbid salts, and especially to be rendered turbid by the presence of urate of ammonia and soda a few hours after the ingestion of food, at a temperature between 50° and 60° Fah. However weak the patient, I am persuaded that, as a general rule, no good can be derived from stimulants when this occurs. This clinical fact, as we shall see hereafter, is a most valuable guide in practice with reference

to the administration of stimulants to the weak and to the dyspeptic.

Defective Nutrition from an Over-supply of Food.—Although at first the assertion may appear paradoxical, yet the fact is probable that in the middle or upper classes of society more human beings suffer in health and strength from taking too much food than from taking too little. To insure the preservation of the organization, an all-wise Providence has made the satisfaction of food-wants a pleasure; and thence the general tendency, when the supply of food is unlimited, to take more than is necessary, to eat for the pleasure of eating.

As an illustration, we may point to the agricultural population, which, with a few exceptions, is the longest-lived section of the community; and yet how small the quantity of food on which they are obliged to live, even in our own favoured country! The father, mother, and children, in an agricultural labourer's home, have not only to live, but to pay all expenses with from ten to twelve or fourteen shillings a-week when in full work. A town tradesman and his wife will consume more than that, in positive food-value, on dinner alone. Many a dyspeptic invalid, wrapped up in woollen and silk, and kept warm by large fires, eats and drinks much more than ten shillings' worth of food a-week before he or she reaches the dinner hour.

As might be presumed from the marvellous prevision with which compensating and equalizing

conditions are provided in the animal economy to meet the sudden strains to which it may be subjected, the ingestion of an overplus of food is not necessarily injurious at the time. It either passes away undigested through the intestinal canal—as probably occurs with voracious eaters—or it is transformed into chyle as usual. In the latter case the overplus carbonaceous element is either deposited in the cellular tissue, in the shape of fat, or burnt by its combination with oxygen, and excreted by the lungs and the skin, as carbonic acid, or eliminated by the liver as bile. The overplus nitrogenous element is excreted by the kidneys as creatin, urea, uric acid, or urate of ammonia.

Fat is an essential element of the human body, and has important uses to perform. It serves as a kind of soft mattress to the skin, which it lines everywhere, and as a cushion to many organs which are more or less imbedded in it. In the female it is much more freely developed than in the male, and by filling up the interstices of the organs gives to her form the graceful roundness by which it is characterized. Fat once deposited in the meshes of the cellular tissue, its anatomical seat, is withdrawn to a great extent from the active current of organic life, and appears, to a certain extent, exempted from the rapid changes of disintegration and reconstruction which we have seen to obtain in other tissues.

The excessive deposit of fat, either generally or locally, as on the abdomen, for instance, is generally

the result of over-feeding. With some, however, it is constitutional, and takes place in early life even on a spare diet. In many instances the tendency shows itself in a very marked manner after the age of thirty-four or thirty-five, and that in perfect health; whilst in others it is the result of depraved and defective digestion.

Whatever the cause—be it over-feeding, constitutional predisposition, or defective nutritive power—the continued development of the adipose tendency is not unattended with danger. The individual whose economy has been invaded to any great extent by fat deposits becomes obese, unwieldy, and unwilling to move. Indeed not only the will, but the power to take exercise fails. Some stones of abnormal fat have to be moved, carried by muscles themselves weakened through fatty deposit. The fat is at first merely deposited between the muscular fibres, giving them the streaked appearance and texture of fat meat; but as this condition of abnormal nutrition progresses, the fat actually breaks up the muscular fibre, and takes its place, thus giving rise to what is termed fatty degeneration. The same changes take place in the viscera. The heart, lungs, liver, bowels, are at first merely oppressed, smothered, as it were, by layers or cushions of fat which mechanically interfere with their action; but later the fat deposit invades their structure, which becomes weakened, softened—in a word, the seat of fatty degeneration.

These facts have been admirably illustrated by Mr. Gant, in a work on the nutritive state of prize cattle. In this interesting contribution to science, Mr. Gant has proved that the animals, monstrously fattened, to which prizes are given at the cattle show, are in reality mere specimens of nutritive disease, and that very many of them are actually suffering from organic maladies, the result of fatty degeneration of the tissues; and this at the very time they carry off the prize as specimens of legitimate cattle-feeding. All Mr. Gant's arguments and illustrations are equally applicable to the human race.

In all forms of abnormal fatty development, the only remedy, once the tone of the digestive organs has been restored, is exercise and diet. If we are desirous to reduce fatty development or corpulency, as much exercise should be taken as is consistent with strength and health, and a little less food should be ingested than is really required to satisfy the wants of the economy. The way to ascertain the quantity of food thus required, and the only way, is to determine the actual weight of the body every fortnight, and steadily to diminish the amount of food ingested until there is a loss of half a pound or a pound monthly. A rapid diminution in weight might be followed by a dangerous degree of debility and weakness, the result of the real starvation by which it is obtained. But a slow diminution such as described, obtained by exercise as well as by the reduction of food, is attended with no risk whatever.

By increasing the amount of exercise and of exposure to atmospheric vicissitudes, organic expenditure or molecular disintegration is rendered more active. If the food-supply remains the same, the economy is obliged to reabsorb its own fat, to provide for the increased nutritive demand. If, on the other hand, in the absence of increased exercise and exposure, the amount of food is reduced below the nutritive requirements of the patient, the economy is obliged to call upon the fat in reserve to make up the deficiency, and the same result is obtained. We must, however, always remember that the attempt to obtain these results rapidly is attended with great danger; neither people nor animals grow fat all at once.

With animals, the lives of which are comparatively short, and with which organic nutritive changes are comparatively rapid, a few months, or one or two years, are often all that is required to make a lean individual quite obese.

With mankind the change, from leanness to obesity, is generally the scarcely perceived result of many years' progressive increase. An increase of a stone, or 14 lbs. a year, is attained by a daily increase of about half an ounce only. Half an ounce is the nutritive product of one potato, of a small piece of bread or pastry, of a spoonful of rice, *more* than the human economy strictly requires. A stone a year amounts to four, or 56 lbs., in four years. Four stones transform a

thin young man or female into a corpulent man or matron.

Once three or four stones have thus been added to the weight of the burden that has to be lifted and to be carried in walking, how can active exercise be carried out rationally, so as to *rapidly* influence nutrition, so as to wear away this "reserve" of fat? Put 56 lbs. on the shoulders of a young, healthy, vigorous man, of a young soldier, and he will soon say that the burden is too heavy to bear when walking, that it produces complete exhaustion.

Thus, to reduce obesity with perfect safety, the food should be diminished generally, and the result should be tested by weighing at short intervals, so as to secure a diminution, say, of half a pound only during a fortnight, or of one pound, at the utmost, in a month. Such a decrease still amounts to twelve or fourteen pounds in the year.

The food itself should remain the same, nitrogenous (meat), carbonaceous (grain and vegetables), the reduction bearing principally, however, on the carbonaceous element. This should be done under the amount of exercise only that can be borne without producing exhaustion, or interfering with the digestive functions. When exhaustion through exercise is reached, digestion itself becomes imperfect, owing to want of nervous power.

Very few, however, will consent to follow the above rules, because they entail the sacrifice of appetites, and the exercise of self-denial. The

generality of mankind, according to my experience, prefer to see "their shadow grow larger," with all the drawbacks thereto pertaining—which are not few—to vigorously applying the only real remedy.*

The liver, as we have seen, also comes to the rescue, and makes strenuous efforts to purify the blood of the carbonaceous nutritive materials, when they have neither been burnt by the oxygen of respiration, nor transformed into fat and deposited in the cellular tissue. Hence the frequent bilious attacks of large eaters, whose habits of life are not such as to enable them to assimilate legitimately the food they consume. The liver becomes loaded with bile, principally composed of carbon, and every now and then an explosion occurs, in the shape of bilious sickness and headache, or of bilious diarrhoea, or of some other form of biliary derangement.

The nitrogenous element of the food, when in excess, is eliminated by the kidneys as urea, uric acid, urate of ammonia, and creatin. Urea exists normally, as we have seen, in the healthy urine in considerable amount, constituting a large percentage of its solid constituents. It is considered to be principally the product of the disintegration or destructive metamorphosis of the tissues, but it no doubt also represents, in part, the surplus nitrogenous elements of the food.

* [illegible]

The quantitative amount of urea has been scrupulously examined in connection with diet. According to Golding Bird, the average amount of urea excreted by a healthy man is about 270 grains in the twenty-four hours. According to Lecanu, quoted by Dr. Carpenter, the mean amount is greater:—for a man, 433 grains (412·4, Parkes); for a woman, 295 grains; for a child of eight years, 207 grains; for old men, eighty-four or above, only 125 grains. The difference depends evidently on the variable activity of interstitial nutritive changes, rapid in the child, slow in the aged, more active in men than in women.

The quantity of urea contained in the urine increases with violent exercise; thus showing its dependence on muscular disintegration. It increases, also, if nitrogenous food is consumed in greater abundance than is required by the wants of the system; a fact which proves that the nitrogenous element of superabundant food is also thus eliminated.

The formation of urea generally increases during the first stage of febrile disease, even when no food is taken, owing to the rapid destructive metamorphosis or waste of tissue which then takes place. If, however, the abstinence is prolonged, it diminishes. During convalescence, even when nitrogenous food is taken in abundance, the amount of urea is below the normal standard; owing, no doubt, to the nitrogen being employed in building

up the wasted tissues, and to the process of decay or disintegration being, for a time, carried on with diminished activity. It is asserted by Liebig that urea is not formed at once from the metamorphosis of tissue and from the blood, but from uric acid or creatin by a process of oxidation. Golding Bird states that the quantity of nitrogen excreted in the twenty-four hours, in the form of urea, represents five-sixths of the amount taken into the economy in the food.

Uric acid exists normally in the urine, but in much smaller proportion than urea. In health the 42 ounces of urine usually secreted in the 24 hours, at a temperature of about 60° F., contain 8·5 grains of uric acid, generally combined with ammonia and soda, in the shape of urate of ammonia and soda.

This combination insures the solution of the uric acid, one grain of urate of ammonia being soluble in 2,570 grains of water or urine, whereas uric acid alone is only soluble in 8,570 parts of fluid. If, however, the urine is very scanty and concentrated, and the external temperature much below that of the body, the necessary condition no longer exists, and the urate of ammonia is precipitated. In this case the urine becomes cloudy, until the urate of ammonia has collected at the bottom of the vase used.

When urate of ammonia and soda is present in greater proportions than the urine can normally hold in solution at a low temperature, it is always precipitated by the urine on cooling. This

precipitation is of very frequent occurrence, a few hours after the ingestion of food, in the urine of the dyspeptic, and of those generally in whom the process of digestion has been imperfectly performed, from whatever cause. So constantly, indeed, do I observe it, that I have been led to look upon the presence of urate of ammonia and soda, under these circumstances, as the proof that the meal preceding its appearance has been imperfectly digested.

In other words, I believe that in such cases the chyle itself has been defectively elaborated, and has proved unfit for assimilation. Thence its elimination, or at least the elimination of part of its nitrogenous element, by the kidneys, as urate of ammonia and soda.

The above sketch of the various modes adopted by Nature to get rid of a superabundance of food-material shows that overfeeding must necessarily be a much more baneful error than is generally supposed. If the digestive organs perform their duties and elaborate the chyle, the blood is overloaded with nutritive materials, which the lungs, the kidneys, and the liver have to dispose of as well as they can. These superabundant nutritive materials may thus become a prolific source of capillary and systemic, as well as of liver, and kidney, and skin disturbance. If, on the contrary, the overloaded digestive organs succumb, and only imperfectly elaborate the chyle, the latter becomes a source of suffering to the entire economy — a positive poison — until it has

been eliminated by the above-mentioned emunctories. Nutrition under such circumstances is necessarily defective throughout the organization, and a defective organization is built up, a ready prey to every possible form of disease.

Defective Nutrition from Sympathetic Reaction on the Digestion of Chronic Disease situated in other parts of the Economy, and from Functional Derangement or from Organic Disease of the Digestive Organs.—The functions of digestion may be disturbed by the reaction of other diseases, as when they suffer sympathetically from the presence of cerebral, thoracic, or abdominal affections.

They may also be disturbed by the existence of functional derangement of one or more of the organs by which digestion and nutritive assimilation are carried on.

Lastly, when the stomach, liver, pancreas, etc., are the seat of actual disease, modifying their organic structure, the processes of digestion are of course very imperfectly performed, and nutrition is in proportion perverted.

When the digestion of food is healthily and efficiently performed, the various changes which it undergoes occur without the individual having any consciousness of the operations that are taking place in his economy. He merely feels satisfied and well; his hunger is appeased, and his flagging strength is restored, even before the food has been digested and assimilated. The healthy chyle having passed

through the lacteals into the circulation, and having been vitalized by the oxygen absorbed in the lungs, affords to each tissue, to each organ, the nutritive materials which they require.

Thus renovated, thus repaired, all the organs of which the economy is composed are equal to the work that is required of them; no languor, no debility is experienced. The brain acts vigorously, and the thoughts are formed clear and bright; the muscles contract with energy and freedom, and active muscular exertion is a positive want and a source of vivid enjoyment. Thence the sharp. intellect and retentive memory of childhood; thence the constant desire for exercise, the unceasing gambols and gyrations of healthy early life. Sleep is, indeed, refreshing repose, which, closing the eyelids in a few minutes, leaves no scope for dreams or nightmares, and night appears but a fleeting oblivion. When the hours of darkness are over, and the brain awakes, the head is clear, the mouth fresh and sweet, the tongue clean; all lassitude has disappeared; and the economy, refreshed and renovated, rouses itself ready for the labours and pleasures of the ensuing day.

How different the state of the dyspeptic — of the one who, from whatever the cause, does not efficiently digest food. Defective digestion is occasionally unattended with pain, flatulence, or with disturbance of the heart, lungs, brain, indeed of any organ, and is only recognized by its results—

general derangement of the health, and defective nutrition, as evidenced by emaciation or an unhealthy adipose state. Generally speaking, however, the defective digestion of food is accompanied by oppression at the pit of the stomach and in the chest, by flatulence, acid eructations, pain in the regions of the stomach, heart, and chest; by sensations of a foreign substance in the throat, leading to vain attempts to swallow; by nausea and sickness, dryness and bad taste in the mouth; by want of sleep, or by restless and unrefreshing sleep, disturbed by dreams and nightmare, and followed by a parched, white, or loaded tongue. Thus are revealed the sympathetic reactions of the pneumogastric nerve.

These symptoms are the evidence of defective digestion, and are, generally speaking, occasioned by the inefficiency of the stomachal digestion, by the superabundance or morbid character of the gastric juices, by the imperfect solution and chyme transformation of the food, by its fermentation in the stomach and intestines, or by the abnormal duration of the stomachal digestion.

Once the chyle has entered the circulation and become a part of the blood, its imperfect elaboration and its unfitness for the purposes of nutrition give rise to a new train of symptoms. Instead of restoring and renovating the economy, it becomes, as we have repeatedly stated, a positive poison; and the blood, contaminated by the imperfectly elaborated

chyle, carries suffering to every region, from the crown of the head to the sole of the foot.

Thence the headache, mental depression, and general lassitude. Moreover, as the tissues refuse nutritive materials which are not fit for their use, the organic waste is not supplied, and sensations of sinking, of languor, and of faintness supervene, accompanied by a craving for more food, or for stimulants. If food is again given, as is usually the case, the craving is alleviated for an hour or two only.

The mere presence of food in the stomach has the singular power of appeasing the appeals of the body for nutritive materials. This we see in the healthy. The exhaustion of hunger is appeased as soon as food reaches the stomach, long before chyle to repair waste has been elaborated. It is a nervous phenomenon which is aptly illustrated by the habits of savage tribes. When enduring the pangs of hunger on the war-path, or in the chase, they sometimes swallow earth, with temporary relief, although it does not contain the elements of nutrition. But the eventual result is the same; feeding a patient whose digestion is thus imperfect is repeating the never-ending task of the Danaïdes. As the patients often express it themselves, "their food does them no good." The greater part of it merely passes through the economy, contaminating and poisoning it on its way, without serving the purposes for which it is taken.

I say the greater part, because, however defective

digestion may be, a portion of the food ingested is so transformed as to answer the purposes of organic assimilation and of combustion, or death would soon ensue. The relative proportion between the amount of food assimilated, and that which is rejected by the bowels and eliminated by the kidneys and liver, gives the degree to which normal nutrition is impaired.

Thus in one person, the functions of digestion are merely slightly disturbed, there is only slight oppression and acidity after meals, slight headache and occasional sleeplessness; the urine is only exceptionally loaded with urate of ammonia and soda, and nutrition does not visibly flag. There is no loss of flesh, and no unnatural coldness of the extremities. It is, indeed, in such conditions of the digestive organs that a deposit of fat often takes place, and that there is, apparently, an increase in size and in comely roundness of form, which is erroneously thought to be a proof of health. In such cases, part only of the chyle is removed by the kidneys and liver, as unfit for assimilation; and that which is retained for assimilation or combustion is even more than enough to satisfy the wants of the system.

In another person, on the contrary, the derangement of the digestive system is more decided, the symptoms which are thereby produced are more numerous and severe; a greater proportion of the food passes undigested through the intestinal canal,

or is eliminated from the blood by the kidneys, in the shape of urate of ammonia or of uric acid. The result is a deficiency of assimilable material, defective organic nutrition, and progressive emaciation or wasting of the body.

In either case the assimilation or organic nutrition that does take place is not of a healthy nature; imperfectly elaborated chyle, destined to be in part thrown out of the economy as soon as it reaches the blood, is certainly not calculated to support healthy nutrition, nor does it. The organic tissues, thus built up from badly elaborated materials, contain within themselves the seeds of disease. Constitutional and hereditary taints are brought to light and developed, and chronic inflammations are set up; more especially in the liver and kidneys, which are, as we have seen, constantly at work to eliminate the food poison.

Thus, as we have seen, is explained the gradual development of the more severe and fatal chronic diseases of these organs, in their varied forms of cirrhosis in the liver, of albuminuria in the kidneys, of diabetes in the chylopoietic viscera generally.

In enumerating the influences that contribute to the development of the various forms of defective nutrition, above described, I must again call attention to the action of the nervous system. Grief, anxiety, mental strain, depression of spirits, in any shape or form, if long continued, lower the general vitality of the nervous system, and of all the

functions of the economy, which it controls and governs.

Not only is the digestive or chylopoietic system impaired generally, but the more intimate or capillary functions of nutrition may be modified, and thus, any form of morbid nutritive action, of chronic disease, may supervene, from dyspepsia to cancer.

It is in this manner, no doubt, that grief and anxiety kill, by bringing on some fatal form of disease, the result of impaired, defective nutrition; when "dull care sits at the board," and poisons the food. We ought all to strive to bear sorrow and mental suffering with resignation and calmness, if we wish to escape death from some form of chronic disease.

The above facts were markedly and painfully illustrated in the siege of Paris, in 1870. Not only were the defenders of that city badly fed and half poisoned with alcoholic beverages, but they were also in a low state of organic vitality, in a condition of extreme moral depression. The result was that they died like flies in autumn. The slightest wound proved fatal, from pyæmia or gangrene; whilst the slightest general ailment, such as bronchitis or diarrhœa, terminated rapidly in death.

During the last few years the germ theory of disease, has rapidly been gaining ground. It is now, indeed, all but universally admitted that many of the diseases called zymotic, which comprises epidemic, endemic, and contagious diseases, owe their origin to germs, introduced into the organiza-

tion from without. For these germs, however, to take root as it were, to develop, the animal organization must be prepared for their reception. The most efficacious preparation, no doubt, is a low state of vitality from defective nutrition. We are, throughout life, constantly receiving into the economy these germs of disease, but if the nutritive functions are sound, and the organization is healthy, it resists their presence and action. They do not find in it a suitable nidus wherein to germinate, so they are destroyed or expelled. Following this train of thought we arrive at the inevitable conclusion that to escape the attacks of zymotic disease we must be in good health, that is, in a sound nutritive state.

The same fact is observed in the vegetable world. For a seed to germinate it must be planted in a soil congenial to its nature, otherwise it perishes. I have an admirable illustration of this great law constantly under my eyes at my residence in the country. The garden was formerly part of a common, but after twenty years manuring and cultivating, the soil has improved, and grows nearly anything. On the other side of a wire fence there is a wood, the soil of which is entirely sand, with a little peat. It grows heather, gorse, firs, birch, beech, and Spanish chestnut. Their seeds germinate freely, but other seeds, brought by the winds and by birds, seem to perish in this, to them, unsuitable seed bed. Along the outer side of the wire fence there is a slip, some twelve feet wide,

which was formerly covered with chestnut brushwood, My gardeners for years threw underneath this brushwood the mowings of the lawn, the surplus soil of the garden, the old mortar from buildings. After a time I had the brushwood cut down and extirpated, and to my surprise the next summer a hundred wild plants appeared; nearly all the grasses and wild flowers of the neighbouring lanes, ditches, pastures. But their advent was confined entirely to the narrow slip, six hundred feet long by twelve wide, the soil of which had been modified as above described.

The moment the soil became a fit bed for their reception and germination, the seeds of all these plants have burst into life, although they still refuse to do so in the peaty sand at their side. Conversely, this change rendered the soil unfit for the germination of the heather seeds, which are blown on it in myriads by the wind, from the adjacent heather-clad region. They now perish in the, to them, ungenial soil.

By keeping his nutritive condition in a healthy state, and by thus securing a sound, healthy organization, man all but secures immunity from the germs of disease. He renders his organization a nidus, or seed bed, in which the death-bringing germs that modern science reveals, pervading the atmosphere we breathe, and poisoning the water we drink, become innocuous, are killed. They are destroyed outright, or are eliminated without germinating.

CHAPTER VI.

URINARY DEPOSITS IN DEFECTIVE DIGESTION AND NUTRITION.

In the preceding pages I have repeatedly alluded to the presence of morbid salts in the urine as a result and as an evidence of imperfect digestion. I believe their presence to be the most delicate and most easily recognized test that we can bring to bear in the diagnosis of defective digestion, and I am also of opinion that its value, although recognized, has not yet been fully appreciated by the profession. Indeed, I believe that I am fully warranted in stating that, practically, the very existence of the various morbid salts that are usually present, as a result of the imperfect digestion of food, is generally overlooked and neglected.

Healthy urine in man is of a bright amber colour, perfectly clear and transparent, and remains so on cooling, no deposit taking place. If allowed to cool in a wineglass a light floating cloud is generally observed floating in the centre or towards the lower

part of the glass, which consists of mucus secreted by the mucous membrane of the urinary passages. The principal constituents of healthy urine are urea, uric acid, creatinin, chloride of sodium, sulphates and phosphates, colouring matter, and mucus.

Under the influence of defective conditions of digestion and nutrition, and under that of disease, the chemical composition of the urine is modified, and, on standing and cooling, morbid deposits take place. These deposits may, or may not, be accompanied by turbidity of the urine. They consist principally of uric acid, urate of ammonia, purpurine or colouring matter, oxalate of lime, the triple phosphates, the neutral phosphate of lime, pus or blood-globules, epithelial scales, and fibrinous casts of the uriniferous tubules of the kidney. (See Plate.)

It is a popular notion that mere cold renders the healthy urine turbid, but this is a fallacy. Healthy urine remains clear at a temperature of 50° or 60° F., provided it only contains the normal proportion of uric acid in combination with ammonia, viz., 8·5 grains of uric acid for the 42 ounces of urine usually passed in the twenty-four hours. If the urine is more concentrated, or if the urate of ammonia is more abundant, although clear at the temperature of the blood, it becomes turbid from the deposit of urate of ammonia at the lower temperature. The precipitation of this salt, and the consequent tur-

bidity of the urine, become more and more abundant as the thermometer falls.

The general idea that mere cold will cause its precipitation in healthy urine is partly owing to this fact. When the temperature is above 60°, the urine may contain an abnormal amount of urate of ammonia, and yet little or no precipitation may take place; but if it should fall, from change of weather or from a diminution of the temperature of the room—as in a bedroom in winter—a copious deposit will occur. In warm weather, to test for urate of ammonia and soda, a bottle of the urine should be immersed in cold or even iced water, or it can be placed outside the window at night.

The frequency of these deposits in cold weather may be attributed, in some degree, to the action of cold interfering with the functions of the skin, arresting the cutaneous exhalation of effete nitrogenous matter, and throwing the onus of excretion on the kidneys; and also to its often increasing dyspeptic conditions, thus disturbing digestion.

Another cause of disturbed digestion and of turbid water in cold weather is the increase of appetite, which usually occurs under its influence. This increased desire for food often leads to more aliments and stimulants being taken than can be properly digested, especially in the case of those with whom the digestive functions are naturally weak.

These facts must be known and remembered, as

the urate of ammonia and soda deposit is the commonest and the one that principally gives rise to the turbid deposit so often observed in urine that has stood and cooled. Uric acid, oxalate of lime, and even phosphatic deposits, unless very abundant, by no means modify the physical aspect of the water to the same extent.

When investigating the nature and pathological importance of the morbid salts which constitute urinary deposits, the first point to ascertain is whether the deposit is the result of defective digestion only, or of defective assimilation and disintegration of destructive metamorphosis of tissue. To accomplish this the urine must be examined at different times, the greatest care being taken that the urine secreted subsequently to the process of the digestion of food, and modified by the presence of recently formed chyle in the blood, should not be mixed with that secreted when the organic disintegration of tissue alone is taking place.

Thus, the urine should be examined a few hours after the ingestion of food, and especially of animal food, and also after a long fast, the first thing in the morning, for instance. When the digestive functions only are impaired, the urine passed after food, the *urina digestionis*, although clear on being passed, will generally be found to become turbid on cooling, depositing an abundant precipitate of urate of ammonia and soda; whilst that passed fasting, the *urina*

sanguinis, will generally be found clear on cooling, and free from deposit.

For the experiment or investigation to be satisfactorily carried out, various conditions must be observed. The patient must not be suffering from any febrile disease, for, if so, the urine may deposit morbid salts at all times; partly from the imperfect elaboration of food, and partly also from modification in the mode of elimination of the elements of organic waste. Under such circumstances, uric acid and urate of ammonia are eliminated as well as urea, and in the place of urea. Sufficient time, also, must be allowed to pass for the processes of digestion to be accomplished and for the chyle to reach the blood. As soon as the chyle has entered the circulation the kidneys commence their function of filtration or elimination, if it is unfit for assimilation. This elimination they continue until the blood is thoroughly purified. Thus, for some hours after the ingestion of food by a dyspeptic patient, the urine may remain clear, because the chyle has not reached the circulating fluid. Then for a longer or shorter time it becomes turbid, and throws down on cooling a deposit of a pinkish or pale hue, owing to its being loaded with urate of ammonia. In the same specimen will constantly be found, on microscopical examination, uric acid, oxalate of lime, or phosphatic salts. After this it again becomes clear, because the blood has been purified of the impure chyle, and the urine has re-reverted to its normal character.

Such being the case, to test the digestion of food by the state of the urine, we must examine that which is secreted by the kidneys during the hour or two that follows the completion of digestion and the entrance of the chyle into the blood. This period varies, of course, according to the length of time that the food ingested takes to digest; which itself varies, as we have seen, according to the nature of the food, and according to individual peculiarities. Milk, eggs, vegetables, fish, etc., take about two hours; so the urine should be examined two or three hours after their ingestion. Fowl, game, beef, veal, etc., take from two to three or four hours. Thence it is, respectively, from three to five hours after the ingestion of these articles of diet that the urine will be contaminated with the salts eliminated from the chyle they furnish to the blood.

It is well, likewise, to empty the bladder two hours after the meal, to get rid of the fluids taken thereat, which, of course, first find their way to the bladder. Their presence may mar the experiment, as an excess of urine may so entirely dissolve the urate of ammonia and soda, if not abundant, that it is not thrown down by the cooled urine. With some persons the stomachal and intestinal digestion is so slow that a much longer time elapses before the chyle reaches the blood, and is thus abnormally eliminated by the kidneys. In others, the digestive processes, on the contrary, are very rapid, and the morbid deposits must be sought for at an earlier period.

Some precautions, also, are necessary with respect to the examination of the urine of the blood. Supposing the first morning urine is taken for that purpose, as is usually the case, we must take care that sufficient time elapses between the last meal, taken the day before, and the hour of retiring to rest, to allow of the elimination, through the kidneys, of the imperfectly formed chyle. Otherwise the morbid salts may continue to reach the bladder after the latter has been emptied at bedtime, and are consequently found in the urine passed on waking in the morning. Thus, if the dinner is at five or six, no other solid or liquid food should be taken, and the bladder should be emptied for examination between ten and eleven. If the dinner is at two, the urine for examination should be taken between six and seven, before tea or supper.

Even when all these rules are carefully observed, the urine of digestion and the urine of the blood in a dyspeptic patient may be both equally loaded with morbid salts, a condition which implies a very aggravated degree of defective nutrition. It implies not only that the digestion and assimilation of food is imperfect, but also that the organic decomposition, or metamorphosis and elimination of used-up molecular structure, is defective; and that, even in the absence of febrile excitement and disturbance. In such cases the entire series of nutritive processes are morbidly and inefficiently carried on, digestion, chylification, assimilation, and disintegration.

The urine may be very easily submitted to an analysis sufficient for all practical purposes. If it shows a strong acid reaction by reddening litmus paper, the probability is that the deposit is principally urate of soda and ammonia, which are generally combined. This becomes a certainty if on heating the deposit over a spirit lamp in a test-tube the urine loses its turbidity, and again becomes clear and transparent. If the turbidity were due to phosphatic salts, the deposit would remain turbid, the turbidity disappearing on addition of an acid; and if to pus, an albuminous cloud would form and gradually collect at the bottom of the tube. Were albumen present, its solidification by heat would at once give a dense white albuminous cloud throughout the urine, which would also gradually collect at the bottom of the tube.

The microscope throws additional light on the nature of the turbid deposit by actually showing us of what it is composed. In the majority of cases it will be found to consist principally of the double urates (Fig. 2), in the form of an amorphous deposit, which presents the appearance of dust scattered over the field of vision, or aggregated in groups. In the midst are generally seen epithelial scales (Fig. 5), in more or less abundance, and sometimes fibrinous casts or casts containing fat or oil globules (Fig. 6). Rhomboidal uric acid crystals (Fig. 1) are frequently found with the urate of ammonia deposit. Brilliant octahedron crystals

of oxalate of lime (Fig. 3), sparkling like diamonds, are also not unfrequently observed. Crystals of the triple phosphates (Fig. 4) are frequently met with, but not as often as those of uric acid and of urate of ammonia. Pus globules (Fig. 7) are occasionally present, alone or along with the crystals above enumerated. Turbidity of the urine, and the subsequent deposit, may be owing entirely to pus, in which case pus globules alone occupy the field of the microscope. Blood corpuscles (Fig. 8) are also seen in urine containing blood.

The information which the microscope thus throws on the nature of urinary deposits, and on their pathological importance, is invaluable, and can be replaced by no other means of investigation. A microscope of ordinary power, one that magnifies about three hundred times, is all that is wanted, and a practical acquaintance with the principal salts and morbid products which it reveals in urinary deposits may be acquired in a few hours.

The presence of these morbid salts in the urine, when it is only observed after digestion, and merely for a limited time, may be considered to principally denote the existence of imperfectly elaborated chyle in the blood; although it may also be the result of deficient vital assimilating or nutritive power. The kidneys are then acting the part of emunctories, or filters, purifying the blood of chyle which is unfit for assimilation. When uric acid and urate of soda and ammonia are found in the urine at all

times and seasons, independently of the digestion of food, it is evident, as before observed, that a still more advanced state of defective nutrition exists. Not only is assimilation defective, but organic molecular disintegration, or the normal destructive metamorphosis of tissue, is also defectively carried on.

It is probably from the same cause that we find an abundant deposit of the double urates taking place during the latter stages and the convalescence of fevers, and of various inflammatory diseases. The functions of nutrition have been thoroughly impaired, and the digestion of food has been all but at a standstill. The patient has been disintegrating his nitrogenous tissues without repairing them, and absorbing and burning his fat and carbonaceous tissues to keep up the organic combustion, or animal heat. Thence the blood is loaded with waste materials, imperfectly transformed, which are eliminated by the kidneys in the shape of an abundant lithatic deposit.

I believe, however, that even in fever and acute disease, the urate of soda and ammonia deposit, which is often considerable, is in a great measure owing to the imperfect digestion and assimilation of the food given, and not to the retrograde metamorphosis of the nitrogenized tissues. It is now generally admitted that urea is the last product of such retrograde metamorphosis; whereas uric acid, as also oxalic acid, is one of the intermediate products of this metamorphosis. As such, they are

more likely even than urea to represent in the urine a surplus or over-supply of albuminoid food.

The epithelial scales (Fig. 5), which nearly always accompany the lithatic deposits, are thrown off by the mucous membrane which lines the urinary passages. When very abundant, their presence may be considered to be the result of irritation of the mucous surface, produced mechanically by the urate of soda and ammonia. Some persons may have turbid urine from the habitual formation of urates, and of other morbid salts, for many years without irritation of the urinary mucous membrane taking place. With others it occurs as soon as the lithatic urine is secreted by the kidneys, and is productive of much suffering, of pain in the region of the kidneys, darting along the ureters, and of dull aching sensations over the pubis in the region of the bladder. These symptoms are often accompanied by a constant desire to pass water, which rouses the patient several times in the night, and is not even fully relieved by emptying the bladder.

I have met with some patients so extremely sensitive in this respect, that even in health, if the ingestion of food is followed by the formation of urates, they become aware of their presence as soon as the urine reaches the bladder, owing to the sudden pain they occasion. I have attended many patients suffering from irritable bladder from this cause, who had been erroneously thought to labour under stone,

stricture of the urethra, or inflammation of the neck of the bladder.

Fibrinous casts (Fig. 6) of greater or less length, formed in the tubules of the kidney, are not unfrequently seen along with the epithelial scales and the morbid salts. They present, under the microscope, the appearance of hairs, and in them are sometimes entangled urate of ammonia, epithelial scales, oil, or pus, or blood globules, and even crystals of oxalate of lime. Their presence is generally considered to indicate severe irritation or even disease of the kidney. Mere fibrinous casts, however, not containing oil corpuscles, or epithelial casts, are constantly present in simple cases of dyspepsia, in which the kidneys are evidently neither the seat of great irritation nor of actual disease.

When morbid deposits in the urine, the result of defective nutrition, are thus the cause of irritability of the urinary organs, it is in vain to hope for relief until the digestive functions have been restored to a more healthy state, and until the urine has ceased to be loaded with the lithatic salts. The latter keep up constant irritation in the bladder and urinary passages, in the same way as sand constantly thrown into the eye would keep up irritation or inflammation of the conjunctiva.

Uric acid crystals (Fig. 1) are found more or less abundantly under the same circumstances as the double urates, and often in the same patients. I have in vain endeavoured, in some cases, to find

a distinct cause or reason for their presence or their absence; as also for their appearance and disappearance in the same person. Their constant existence undoubtedly indicates a more decidedly depraved state of the digestive functions, and a more debilitated, broken-down condition of the general health, than is shown by the presence of urate of ammonia alone. It is frequently observed in persons presenting the gouty or rheumatic diathesis or constitution.

I am thus disposed to think that the presence of uric acid and of lithates in the urine, in such abnormal quantities as to constitute a deposit, is very much more frequently the result of defective digestion than of defective metamorphosis of tissue, especially in dyspeptic individuals. This is not the generally received opinion, but that it is really the case appears to me evident, from the circumstance that I am able, in the majority of such cases, to trace them to the food ingested a few hours previously, and that they disappear from the urine secreted after a prolonged fast.

I have made many experiments as to the influence of exercise in the production of uric acid and of urates, which corroborate this view. Were the presence of an abnormal quantity of urates in the urine the result of mere metamorphosis of tissue it ought always to be found after active exercise, from the destruction of tissue which exercise entails; but such is not the case. The urine will remain

clear after exercise continued during many hours, generally speaking, provided no food be taken. When it is subsequently turbid I find that I can nearly always connect the change with imperfectly digested food taken during the exercise.

The oxalate of lime deposit (Fig. 3) has presented itself to me under the same circumstances as that of uric acid and of the double urates, and often in the same cases. The existence of oxalate of lime is supposed, by most writers, to be indicative of a peculiar diathesis, but I have failed to detect the existence of a condition worthy of such a term in the majority of dyspeptic patients who present it. Uric acid, urate of ammonia, and oxalate of lime appear to me to be, generally speaking, indicative of the same organic states—viz., defective digestion, assimilation, and disintegration; in a word, to be the result of what I have termed defective digestion and nutrition, and to answer the purpose of eliminating nitrogen from the economy. The octahedron crystals of oxalate of lime are alone characteristic, but the crystals may also assume the shape of dumb bells, of discs, or of well-defined diamonds. Such crystals are not characteristic, as they are met with as crystals of lithates, of carbonate of lime, and of uric acid.

Nitrogen is eliminated from the blood by the kidneys, in the form of creatin and creatinin, as well as in that of urea; but these substances are rarely met with in urinary deposits, however defective

nutrition may be. Little practical advantage, therefore, can be derived from a knowledge of the fact.

The lithatic deposit is, nearly always, more or less coloured by the extractive colouring matter of the urine, to which the term purpurine is given. On its greater or less abundance in the urine depend the various shades of colour, from pale fawn to deep pink or brick hue, which these deposits present. Purpurine is a carbonaceous substance, containing as much as from 62 to 68 per cent. of carbon; and its presence in the urine is considered to indicate defective elimination of carbon by the usual carbon emunctories, the lungs, liver, and skin. Urate of ammonia and soda, on depositing in cooled urine, has the peculiar power of causing its precipitation.

Thus, the presence of a high-coloured lithatic deposit not only implies something wrong in the nitrogen supply, elaboration, and elimination, but also something wrong in the normal excretion of carbon, some arrest in the action of the lungs, liver, or skin, for which the kidneys are endeavouring to make amends.

The crystals of the triple phosphates (Fig. 4) and the amorphous deposit of the phosphate of lime, are not so frequently met with in persons who are merely suffering from disturbed digestion and defective nutrition, as deposits of the double urates, uric acid, and oxalate of lime. When the tendency to their formation exists, however, it appears to be connected with a much lower state of organic

vitality, with a greater depression of nutritive power. Phosphatic deposits are principally observed in those persons in whom the nervous system has been too greatly and too continuously used, and the general vitality thereby lowered. When this is the case, there is of course a more rapid disintegration of the phosphatic salts which enter so largely into the structure of the brain and of the nervous centres generally. The acid phosphate of soda, which, by its reaction on the triple phosphate and the phosphate of lime in the healthy urine, secures its solution, is no longer in sufficient quantity to prevent the precipitation of the abnormally abundant phosphates, and they are thus more or less copiously deposited.

Phosphatic deposits are frequently observed in cases of cerebral or spinal disease. They are considered to be due to the decomposition of urea in the bladder, and to the union of its elements with those of water. Carbonate of ammonia is thus formed, and its base, by uniting with the normal acid of the urine, precipitates the phosphates. Chronic irritation of the bladder is often followed by the same results; the unhealthy mucus secreted by that organ acts as a ferment, and chemically modifies the constituents of the urine in the same manner.

The triple phosphate is at once recognized by its beautiful triangular prisms, but the phosphate of lime merely deposits as an amorphous powder. It may, however, be easily recognized by its forming

a cloud in the urine, even before it has collected at the bottom of the glass as a deposit, by its resisting the action of heat, and by its disappearing under the influence of an acid poured in small quantity into the urine. If the tendency to its deposit exists, it is often found in the urine passed a couple of hours after breakfast, when a considerable quantity of bread has been eaten. Wheat-flour containing a large amount of phosphates, its origin in such cases is obvious.

Phosphatic deposits are frequently met with in the urine of divines, barristers, physicians, statesmen, literary characters, and of those generally who use their brain to excess, when they are suffering from dyspepsia. Such a fact points to the absolute necessity of diminishing the headwork in the treatment of these cases.

The presence of pus globules (Fig. 7) is the undeniable evidence of inflammatory action in the urinary organs. If they are found constantly in the urine, they may be considered to be the result of inflammation of the mucous membrane of some region of the urinary system. If they are only found occasionally, and in large quantity, after attacks of pains and spasm in the region of the kidneys, we may conclude that an abscess, scrofulous or otherwise, has formed in the kidneys and burst into the calices. The presence of thousands of pus globules floating in the field of the microscope, and thus revealing what is taking place in the penetralia

of the economy, is an admirable illustration of the light which the microscope throws on the subject of urinary deposits.

I have met with a few cases in which the presence of numerous pus globules was owing to inflammation, or catarrh, of the mucous membrane lining the calices of the kidneys, a diagnosis verified by the subsequent progress of events.

The existence of blood corpuscles (Fig. 8) is equally conclusive as to the presence of some internal source of hemorrhage.

The specific gravity of urine, loaded with urate of ammonia, is sensibly modified, and varies between 1020 and 1030. A higher degree of specific gravity would, of course, render the existence of diabetes probable. In diabetic urine, however, the urate of ammonia deposit often does not take place. Nutrition is otherwise modified, and otherwise defective. For more extended details respecting urinary deposits, I must refer to the numerous works which specially treat on the subject of kidney and urinary diseases.

In examining the urine chemically to elucidate the nature of urinary deposits, it is well always to ascertain whether it contains albumen or sugar.

The presence of albumen is often, but not always, the evidence of the existence of some of those forms of chronic disease of the structures of the kidneys, which are comprised under the name of albuminuria, or Bright's disease.

Albumen in the urine is easily detected, as we have stated, by heating the urine in a test-tube over a spirit lamp. The solidified albumen forms a white cloud, which subsequently collects at the bottom of the test-tube as the urine cools. The same solidification of albumen in the urine takes place on adding a few drops of nitric acid. If the urine contains amorphous phosphatic salts, the action of heat may precipitate them, and cause the urine to become cloudy; but the addition of a few drops of nitric acid at once clears it with effervescence. Thus, in double testing for albumen, it is well to use heat first, and nitric acid secondly.

The presence of free sugar in the urine points to the existence of diabetes glycosuria, a mysterious malady, for its intimate nature is even yet a problem. As already stated, it appears to be more a disease of nutrition than a disease of the kidneys.

The specific gravity of diabetic urine is generally much increased, averaging from 1030 to 1040. The simplest and easiest applied test for sugar is the liquor potassæ test. Add an equal part of liquor potassæ to the suspected urine, mix by shaking, and heat one end of the test-tube over a spirit lamp. If there is sugar, the part heated to the boiling temperature will become of a reddish-brown, owing to the transformation of the sugar into glucic and melassic acids. The more sugar the more intense is the dark-red hue.

The copper test is also very generally used: add

a few drops of a solution of sulphate of copper to a drachm of urine and half a drachm of liquor potassæ, which will produce a pale-blue tint on agitation. Then boil, and if sugar is present, a yellow or red precipitate forms. Should albumen also be present, it must first be separated by heat.

Both these diseases, which terminate the lives of a considerable proportion of the members of the human family, are, in my opinion, too much studied *per se*, as individualities, as entities. I firmly believe that their development is generally preceded by years of defective nutrition and of morbid urinary deposits—that is, by the existence of the very conditions described in this work. The kidneys, the liver, and the other organs, the functions of which are the same, act with more or less success as emunctories, as filters, during five, ten, or twenty years, in order to eliminate from the economy imperfectly-elaborated nutritive elements. At last they succumb, and serious, often fatal, disease supervenes.

When the various forms of chronic kidney disease are recognized by actual physical symptoms, when the actual functions of assimilation and disintegration become so faulty that sugar, in greater or less abundance, is thrown out by the kidneys, the mischief is done, and the resources of therapeutical treatment are of but slight avail. The time for real efficacious action is before this, in reality, final stage has been reached, when the conditions of

defective nutrition which I have described alone exist.

It is very desirable that the facts, which I have described in these pages, should be known and accepted by the profession. Were it generally recognized that defective nutrition, as evidenced by the habitual presence of urinary deposits, leads in the long run to fatal disease, and more especially to albuminuria and to diabetes, I believe that these diseases would not be so prevalent, would not terminate so many lives.

Many of my patients, companions, friends, have thus died, and I have known for years that they were on this fatal track; but, as in the case of Cassandra of old, my warnings were not heeded.

In concluding this chapter, I must repeat that I am convinced, from my own experience, that it is utterly impossible to rationally regulate the all-important question of diet in ill-health and disease, without the information which can only be acquired by the examination of the urine and of its deposits. Divested of minute scientific development, that examination, as we have seen, is a most simple matter, and does not require any very extensive knowledge, either of chemistry or of the microscope. The greater the knowledge possessed, however, the more certain are the results obtained; and there is, therefore, every inducement to the student and to the practitioner to pursue their researches.

CHAPTER VII.

PRACTICAL DEDUCTIONS—FOOD REQUIREMENTS IN HEALTH —FOOD REQUIREMENTS IN ILL-HEALTH.

Food Requirements in Health.—In health and left to himself, man requires no rules to teach him how to select his food; an infallible instinct guides him to that which he requires to satisfy the wants of his organization. His nitrogenous tissues grow and waste from use, and in order to afford them the necessary materials of growth and repair, he instinctively seeks and consumes nitrogenous aliments, flesh and other animal substances, and those vegetables which, like bread, contain nitrogen in the greatest abundance. His body is always, in all climes, in all seasons, at a temperature of about 98°. To keep up this heat it requires fuel, carbon; so carbon is sought and consumed in the shape of vegetable substances, in that of oils and fats, and of alcoholic beverages.

Instinctively, as we have seen, man increases the supply of nitrogenous or carbonaceous food, or of both, according as pursuits, position, or climate

increases the organic demand for waste-repairing or for heat-creating materials. The habit of self-indulgence, the idleness and want of occupation which attend upon ample means, or the desire to drown care, one or all often lead to the ingestion of more food and of more alcoholic stimulants than are required. But these deviations from the law of nature, from the instinct which prompts man only to take the kind and the amount of food that his economy requires, do not invalidate the rule; indeed they rather confirm it, inasmuch as such deviations are followed, all but invariably, by disease and by organic ruin.

On the other hand, in the lower classes of the population, in uncivilized life, in sterile, mountainous, uncultivated countries, the food supply is often deficient. When this is the case, all the evils connected with imperfect nutrition from deficiency in food supply are developed.

Apart from such social conditions, when the supply of food is merely a question of will, healthy, rational individuals may safely be left to follow the dictates of their own wants and tendencies with regard both to the quality and quantity of their food; as these tendencies may be said to interpret their instinctive organic requirements. As I have already stated, food requirements and peculiarities vary, within such wide limits, in different individuals, that it is all but impossible to lay down any general rule as to the quantity of food required.

In some persons the digestive process being very rapid, frequent meals are required, even when abundant. For want of food at comparatively short intervals, for instance four or five hours, sensations of sinking and faintness come on, and if the desire for aliment is not gratified the appetite disappears, and general prostration with headache and even nausea ensue. Such persons are often large eaters, require much animal food, and probably do not thoroughly digest all they take; consequently the residue, the evacuations, with them are copious and voluminous. If the urine remains quite free from morbid deposits, at all times in the twenty-four hours, they may remain healthy and well. Nutrition with them is active and vigorous; consuming and assimilating large quantities of food, of fuel, they are or ought to be strong, and equal to a great deal of work. They are like a powerful steam engine supplied by a large tender of coal.

In others, on the contrary, the digestive process appears to be very slow. When hunger has been appeased, the desire for food is long in again making itself felt. Such persons are generally satisfied with two or at the most three meals a day. They often are not large eaters, do not require so much animal food, and can bear, much better than the former, accidental or forced abstinence. It is to be presumed that they extract more completely

the nutritive elements from the food ingested, and thence it is they can thrive on less food, and can take it at longer intervals. As a necessary consequence, also, the food residue is less in volume and weight.

Dyspepsia frequently overtakes those who present this constitutional peculiarity. Their digestive powers unfit them for the food habits of those first described, which, unfortunately, they often adopt from imitation, social obligations, or medical precept. The result is that the digestive system, overpowered by an amount of work which it cannot perform, at first rebels, and then deteriorates ; dyspepsia, with all its horrors, becoming established; see this even in children.

Those who present this peculiarity of digestion have also much to suffer from the popular fallacy which represents the stomach as an organ that ought never to be empty during wakefulness. With very many persons it is a matter of creed that from early morn until late at night food should be taken every three or four hours, lest the stomach should remain empty, a state which is supposed to be attended with absolute danger to the organization.

Such fears, I need scarcely say, are perfectly groundless. The stomach is a mere instrument, an organic cooking apparatus, the office of which is to dissolve the food introduced into the system, and to

prepare it, by the processes we have described, for the subsequent digestive stages. During the time it is so engaged, it labours very actively, secreting the gastric juice and vigorously and incessantly contracting on the food it contains. Once, however, stomachal digestion is completed, and the chyme has passed the pylorus, as we have seen, all secretion ceases, the stomach closes on itself, and a period of perfect rest and quiescence ensues, which lasts until food is again introduced, when the "hard labour stage" again begins.

Thus, the object of the stomach-labour is merely to prepare the alimentary materials required by the economy at large. If these materials have been elaborated in sufficient quantity and in sufficient perfection to satisfy the wants of the system, the object is attained, the stomach has done its duty, fulfilled its mission, and until the materials it has elaborated have been consumed, or thereabouts, it has no function to perform, and is better empty than full. If left empty for a time, it rests, has leisure to recover its nervous, muscular, and organic power, to prepare itself, in a word, for the labours which the next meal will entail upon it. When, on the contrary, it is immediately refilled, its powers are again and again taxed, and unless they are equal to the labour imposed upon them, they flag, the gastric secretions become depraved, and digestion and nutrition are defective.

The powers of digestion, stomachal and intestinal,

whatever they may be constitutionally, are greatly modified by the requirements of the organization and by habit. In childhood, when nutrition has not only to repair the wear and tear of tissue, but also to provide for increasing organic development, the digestive powers are very great, as evidenced by the proverbial hunger of the young, and by their singular capacity for disposing of large amounts of food. They are also remarkably strong during the convalescence from acute disease, in the course of which there has been great organic waste, and consequent emaciation. For the time, the stomach becomes endowed with unusual energy and with never-flagging powers, until the organic loss has been repaired, wholly or in part, when the digestion resumes its wonted capabilities and peculiarities. The digestive powers also become very active when the economy has to make good and repair great and continued organic wear and tear occurring under circumstances favourable to health; as, for instance, during continued and unusual bodily exertion, such as a pedestrian or shooting excursion in a mountainous country.

In all these cases the increase in the organic activity and labour-power of the stomach, and of the other organs concerned in the elaboration of food, is the result of increased requirements on the part of the animal economy. It is an admirable illustration of the adaptation of means to the end in view, which we everywhere discover in Nature.

The evidence of such nutritive requirements is to be found in the existence of healthy hunger, which is the call of the organization for waste-repairing and heat- and force-producing, or nutritive, materials. When they are deficient, hunger, or the desire for food, is experienced. In health the feeling of hunger is rather a pleasurable one. It is appeased at once by the ingestion of food, and when digestion is perfect does not return for several hours; in some for many hours. In ill-health it is not so much hunger of this description that is experienced, as a languid craving for food, accompanied by sensations of sinking and pain at the pit of the stomach. These sensations are generally, not always, appeased by aliment, but they return with renewed force a short time after its ingestion. This return is due to the process of digestion having proved, in great measure, a deception, a delusion. Part of the food, imperfectly dissolved by the gastric juice, has passed through the bowels, part transformed into imperfect chyle is in process of elimination by the kidneys and liver, and a small portion only has answered the nutritive purposes for which the food was ingested. Thence it is that the want-cry of the organization again makes itself heard.

When large masses of healthy individuals have to be fed, as in workhouses, in gaols, in the army, it becomes possible, as we have stated, to establish, approximately, the amount or weight of food required. All are placed under the same social conditions, as

regards exercise and exposure, and the deficient requirements of the one make up for the extra requirements of the other.

In such agglomerations of mankind it has been found that from thirty to thirty-five ounces by weight of mixed vegetable and animal food are required to secure soundness of health for a continuance in men; rather less in women. Two or three pints of water, or of some other fluid, are also requisite to satisfy the fluid wants of the economy, the quantity varying with temperature. If masses of men are fed on a much lower dietary, their health fails. Hard-working men, much exposed, may require more. Invalids, valetudinarians, who take no exercise, and are artificially protected from the vicissitudes of the atmosphere, can live on very much less, half, one-third, one-quarter. But they merely live, do not thrive, and are totally unequal to any continued arduous exertion or labour.

Life itself may be merely kept up, sustained, on a very small amount of food, in some instances on a marvellously small amount. This is instanced in the animal creation by hybernating animals. At the commencement of the winter they fall into a lethargic slumber, and live on their own fat for months. It is illustrated in man by the numerous well-authenticated instances of hysterical or mystical women who have pretended they could live entirely without eating, and who certainly must have lived, generally in a species of trance, on

an infinitesimal amount of food. When these women have been well watched the fraud has generally been discovered, and it is assumed by physiologists to have always existed, even when not discovered.

A love of fraud is innate in the minds of some members of the human family, and more especially in those of hysterical women. I have seen many remarkable instances of it in the course of my long professional career, and one deserves to be placed on record.

In 1826 a committee was appointed by the French Académie de Médecine to examine into the doctrines of "animal magnetism," which was then attracting much attention. An elaborate series of experiments and investigations were carried out by this committee, composed of some of the most scientific men of the day. The most remarkable person experimented upon was a woman named "Petrequin." She appeared to develop powers and capabilities totally inexplicable by our present knowledge of physiology and of physical science, and the fact of her appearing to do so led to a report from the committee rather favourable to the asserted mysteries of animal magnetism.

Many years afterwards, in 1840, I was resident physician to the hospital of La Salpetrière, Paris, and this woman came under my care to die of incurable disease—phthisis. A few days only before she died, she confessed to the priest who attended her that in all that had occurred in 1826 before

the committee she had been a deceiver; all her assumed powers were a deliberate fraud. The Priest refused to give her absolution unless she confessed the past deception to the physician who attended her, and to me, which she did. On being questioned as to her motive for practising so gross and continued a fraud in former days, she replied, that she had none, unless it were a feeling of exultation that she, an ignorant girl, could deceive a body of the most learned and scientific men of the age. Had it not been for this death-bed confession, exacted by the priest under the threat of denial of absolution, all the marvellous powers assumed by this woman would have gone down to posterity as truths, sanctioned by the attestation of a number of scientific men, after deliberate investigation!

A French scientific writer, M. Payen ("Des Substances Alimentaires," 1865, 4th edition) gives the following data for the establishment of a dietary on scientific grounds. He estimates the carbon and nitrogen eliminated from the human body in twenty-four hours to be as follows:—

		Grammes.
Carbon:	Respiration	250
	Kidneys	45
	Excrements, mucus, skin .	15
	Total . . .	310 (10⅓ oz.)

		Gram.	Cent.	
Nitrogen:	Urine	14	5	
	Excrements, mucus, skin	5	5	
	Total	20	0	($\frac{2}{3}$ oz.)

Thus, to keep up the strength and health of man under ordinary circumstances, his diet must contain $10\frac{1}{3}$ oz. of carbon and $\frac{2}{3}$ oz. of nitrogen. M. Payen calculates that it requires about 130 grammes ($4\frac{1}{3}$ oz.) of concentrated nitrogenized food flesh, to produce this amount of nitrogen.

Individual Peculiarities.—Habits modify singularly the powers of the digestive system, and it is to this fact, in a great measure, that we must attribute the different food customs of different nations. The human organization in the earlier period of life is very elastic, and, provided the chemical materials of nutrition are regularly supplied in sufficient abundance, it has the power of adapting itself to nearly any conceivable variation as to nutritive material, and as to hours of feeding. In this feature of his organization, man illustrates the medium position which he occupies between herbivorous and carnivorous animals. The latter are mostly satisfied with one flesh meal in the twenty-four hours. The former, when grazing in a pasture, are feeding the greater part of the day. In the carnivora the flesh food is a ready-prepared quaternary nitrogen compound, which has merely, as it were, to be dissolved and transferred to the structure

of the animal that consumes it, whereas in the herbivora a much more complicated digestive transformation has to take place. Moreover, a much larger amount of food is required, on account of the small quantity of nitrogen contained in vegetable substances. When man feeds on flesh he approximates to the carnivorous animal, and requires less food and that less frequently than when he feeds on vegetable aliments.

Just as the stature, features, and bodily proportions assume a characteristic peculiarity in each individual during the period of growth, so the organic system also receives a stamp, the result of early habits, which usually lasts throughout life. The habits of organic life, if we may so term them, are particularly marked in the digestive system. A man who has been brought up to the adult age on a very animalized dietary, in after-life requires such a dietary more than the one who has lived principally on vegetable food. Again, the one who has been accustomed until middle age to eat often may not, with comfort and advantage, be able to supply the wants of his system by two meals only; and yet this system of feeding may perfectly agree with his neighbour, early inured to it. Thus it is that the German, the Frenchman, and the Englishman become habituated to the food and food hours which obtain in their respective countries, and that their digestive powers often give way when they change their residence, and endeavour to con-

form to the novel habits of their new place of abode.

These facts were well illustrated by what occurred during the Franco-German war (1869-70). Many thousand French prisoners were fed on the usual dietary of the German soldiers—sausage meat, coarse bread, and beer. The common soldiers, peasants and artisans, accustomed to a coarse and spare dietary at home, did very well, throve, but it was not so with their officers. The latter became dyspeptic and ill, and in many cases their health was broken down and ruined. I have attended at Mentone several in whom the seeds of fatal disease, principally phthisis, were thus sown.

It is worthy of remark that a change in food-habits is very much less likely to be injurious to health when it takes place in the sense of greater abstemiousness, than when it involves increase in the amount of food. There are few adults who have the command of food who do not take both more nitrogenous and more carbonaceous aliment than is strictly required. Consequently with the great majority there is a margin for retrenchment which may be infringed upon with impunity, and often with positive advantage.

Thus we see that, in health, man may, like the animal creation, safely consult his instinctive desires and early habits with regard to food requirements. His instinct will lead him to take that kind and that amount of food which his economy requires. As

he can extract waste-repairing nitrogen from vegetables, and heat-creating carbon from the fat and fibre of animal tissues, he can live either on an animal or on a vegetable diet, or can, as he generally does, combine the two. He can also, by the compensating powers of his organization, either extract a great deal of nutritive material from a little food, or a comparatively small amount of nutritive material from a great deal of food, and all without injury or suffering, provided the deficiency or superabundance of nutritive materials be not continuous. If they are, in the one case his body wastes and he becomes emaciated; in the other, in the course of time, disease generally supervenes.

Food Requirements in Ill-health.—In ill-health, on the contrary, man loses, more or less, this marvellous power of nutritive adaptation. He can no longer trust to his secret instincts, which are in default; for hunger is absent, or if present, is morbid and depraved. In ill-health, therefore, he must accept guidance, must become amenable to dietetic rules, and on their correctness depends his safety. That the rules which must guide us in ill-health should be founded on a knowledge of what occurs in health is self-evident; therefore we have now to see how the facts developed in the preceding pages apply to nutrition in ill-health.

The popular idea with regard to food in ill-health, that it is synonymous with strength, is, as I have endeavoured to show, a fallacy, a delusion. To

imagine, as so many do, that to introduce large quantities of animal food into the stomach of persons who are weak through the reaction of local disease, or through functional disturbance, is necessarily to strengthen them, is not only contrary to physiological reasoning, but is contrary to facts; for such a course is seldom followed by any other result than by an increase of the nutritive mischief. The digestive powers become impaired, the food ingested is imperfectly elaborated and partly ejected, and nutrition flags.

Thence, in addition to the Protean ailments which accompany dyspepsia, we have increased weakness and debility, coldness of the extremities, and either a deposit of fat in the system, or emaciation. As nutrition becomes more and more defective, the fat is absorbed and emaciation becomes the rule.

When debility and loss of flesh are thus the results of defective digestion and assimilation, the plainest common sense will tell us that it is not to be remedied by plying the patient with additional food, however nourishing (nitrogenous) that food may be. In vain do we increase the amount of the animal substances ingested, and give stimulants—wine, beer, cordials—if the stomach cannot properly transform what it receives. The only result is still further to oppress and fatigue it, to keep up irritation of the digestive system, should irritation exist, to increase the quantity of imperfectly-elaborated chyle, which poisons the blood, and to tax still

further the eliminating power of the kidneys, lungs, liver, and skin.

The common-sense course which we ought to follow when nutrition is thus defective is: first, to remove any co-existing disease which may, by its sympathetic reaction, occasion and keep up disturbance of the digestive system; secondly, to give the suffering digestion as little to do as is consistent with the nutrition of the economy, until disease be removed, and functional derangement be subdued.

It is absolutely necessary that any general or local disease which reacts on digestion and nutrition should be subdued; otherwise the most scrupulous dietetic management and the most enlightened medicinal treatment fail to restore the digestive functions to a state of health. The morbid reaction of the general or local malady being constantly exercised, undoes the good that treatment effects, and the defective state of the nutritive functions is indefinitely prolonged.

In the practice of medicine this important fact is constantly exemplified, but in no class of diseases is it more frequently and strikingly illustrated than in uterine affections. The sympathetic connection between the uterus and the stomach is physiologically very great, as proved by the sickness which accompanies pregnancy. In uterine disease this sympathetic connection is generally called into play, and, consequently, depraved digestion and nutrition are of constant occurrence. As long as the uterine

disease is unnoticed or uncured, every possible means of treatment may be employed in vain to restore the digestive powers. Change of air, diet, medicine, all fail. But as soon as the uterine malady is treated and subdued, the very means which failed before prove readily successful.

The second indication is to give the digestive system, and especially the stomach, as little to do as may be consistent with the nutrition of the economy, until its powers are restored; the very reverse of what is constantly done. If weakness and emaciation are observed, the general tendency, as I have stated, is to meet these conditions of the system by animal food, given frequently and at short intervals, and by alcoholic stimulants; in order to "support the strength and to remedy the weakness." The sinking, craving sensations of the patient render this plan of diet, in most cases, rather grateful than otherwise, as it temporarily remedies these painful sensations, and gives also, for the time, artificial strength. It is, therefore, readily adopted.

The slightest reflection must, however, show that this system of dietary is not calculated to restore the weakened, exhausted powers of the digestion. During the entire period of stomachal digestion the stomach is very actively engaged. Its glandular system is secreting gastric juice—a process attended, as we have seen, with the successive formation and destruction of gland cells; and its muscular

structure is vigorously contracting so long as it contains food.

We must also bear in mind, that the more dense the structure of the food, the longer the stomach takes to dissolve it, and to prepare it for the subsequent digestive stages. Thus animal substances take a longer time than cooked vegetables, and the more compact the animal fibre, the longer the time employed in its dissolution. Cooked vegetables, as we have seen, are dissolved by the gastric juice, and pass out of the stomach in from one to two hours; milk, eggs, and fish, in about two hours; fowl, and game, and mutton, in from two to three; beef and pork in from three to four; salt meat, in four or five. In persons whose digestion is naturally slow, and in many in whom it is weakened by disease, the time employed may be much greater.

Such being the case, it is clear that the oftener food is taken into the stomach the more work that organ has to perform, and that the duration of its labours is considerably increased when meat is the principal article of diet.

The prevailing idea that there is immeasurably more nourishment in meat than in any other kind of animal food, is an error. Meat owes its waste-repairing or nourishing properties to the albumen, or nitrogen compound, which it contains. But albumen is also one of the chief elements in all other kinds of animal food—milk and eggs, fish and fowl.

The following table of Schlossberger and Kemp, quoted by Dr. Carpenter, in his "Principles of Human Physiology," conveys a good idea of the relative waste-repairing powers of different kinds of food, vegetable and animal. Taking human milk as the standard of comparison, the amount of nitrogen it contains is represented as 100, whilst that contained by the other substances is represented by the figures appended to them.

VEGETABLE FOOD.

Rice	81	Wheat	144
Potatoes	84	Carrots	150
Turnips	106	Brown bread	166
Rye	106	Peas	239
Maize	125	Haricot beans	283
Barley	125	Agaricus deliciosus	289
Oats	138	Beans	320
White bread	142		

ANIMAL FOOD.

Human milk	100	Herring, raw	910
Cow's milk	237	„ boiled	816
Oyster	305	Haddock, raw	920
Yolk of eggs	305	„ boiled	816
Cheese	447	Flounder, raw	898
Eel, raw	434	„ boiled	954
Mussel, raw	528	Pigeon, raw	756
Ox liver, raw	570	„ boiled	827
Pork, ham, raw	539	Lamb, raw	833
„ „ boiled	807	Mutton, raw	773
Salmon, raw	776	„ boiled	852
„ boiled	610	Veal, raw	873
Portable soup	764	„ boiled	911
White of egg	845	Beef, raw	880
Crab, boiled	859	„ boiled	942
Skate, raw	859	Ox lung	931
„ boiled	956		

An attentive study of the figures contained in this table will show that the quantity of abuminous matter contained in fish and fowl is equal, in some instances superior, to that contained in meat. Thus in boiled skate, flounder, and pigeon, the numbers are respectively 956, 954, and 827; whereas, in boiled beef and mutton the numbers are 942 and 852. Thus is demonstrated the important but little-known fact, that fish and fowl are just as nourishing, if they suit the state of the digestive organs, as beef or mutton, or any other kind of animal food. They contain, in reality, the nitrogenous elements required for the repair of organic waste in the greatest possible abundance, although erroneously supposed by the popular voice to be mere helps to nutrition, and not to be alone depended on.

In milk the nitrogen compounds—the albumen and the cheese, or casein, as also the carbon compound—the fat or butter, are held in solution by a considerable quantity of water. In eggs the white or the albumen, and the yolk or the fat, are also fluid, although in a more condensed state than in milk. In fish and in fowl the albumen is still more condensed, and is consequently solid. Whilst in meat, or the flesh of animals, the condensation is still greater; the albumen which composes the greater part of the muscular tissue being deposited, as it were, in a network of non-nutritious fibrous tissue.

Dr. Marcet has shown, in his interesting researches

into the nature of human alvine evacuations, that the residue of the digestion of meat is principally this innutritious fibrous network. As he states, the digestion of meat may be artificially imitated. If we take a small quantity of meat—beef, for instance, and after chopping it very fine, wash it in water, kneading and working it for a considerable time, it becomes blanched, whilst the water assumes a red hue. On raising this water to boiling temperature by means of a spirit or gas lamp, we find that a copious formation of coagulated albumen takes place, whilst the blanched residue, under the microscope, merely reveals, like the fæces, innutritious fibrous tissue. By chopping, kneading, macerating, we do what the stomach does by means of its gastric juice, and its muscular contractions—we dissolve out the albumen.

From the consideration of the above facts, we may conclude that the time the stomach employs in dissolving and transforming into chyme animal substances introduced into its cavity is, in a great measure, regulated by the density of their structure. Thus it is that milk is sooner digested than lightly cooked eggs, eggs than fish or fowl, fish or fowl than meat, mutton than beef, and plain beef than salt beef. Acting on the first, the gastric juice easily dissolves elements that are but loosely aggregated. With the latter, the process of solution is necessarily more lengthened, and the muscular contractions of the stomach are longer continued; for

the food has to be turned over and over, and presented again and again to the secreting walls of the stomach, before it can be dissolved and reduced to a semi-fluid chymous state.

The nitrogenous or waste-repairing element being thus the same in these different kinds of animal food, and the relative proportion in which it is present being also pretty nearly the same, it is clear that they must all be nearly equally "nourishing;" and such is the case—only, they are not equally nourishing to all people.

The healthy, robust adult requires food that will give his digestive organs work to do. The muscles of his stomach require work, as much as the calves of his legs or the muscles of his back. The nitrogen or albumen he wants to repair the waste of his tissues should not be presented to him ready prepared, ready dissolved, as it is in milk and eggs; it is better that he should extract it himself from meat—a process which will give his digestive system the exercise it absolutely requires.

The case is, however, very different with the very young, with the sickly and with the dyspeptic invalid. Nature has provided for the young of the mammalia, in milk, food containing all the elements of nutrition in a semi-prepared state, which only requires a very short time for its thorough transformation into chyle. The same may be said of all oviparous animals; for they live on the contents of the egg in the early stage of their existence. Nature

has evidently wished to spare the delicate organs of the young, in the earliest period of life, the labour which they are destined later to undergo in the elaboration of their food.

The stomach of the strong man, of the navvy, of the drayman, may be compared to a quartz-crushing machine. It wants quartz, that is, strong, coarse food, bread, bacon, pork, beef, to work upon, to crush. To give it eggs and milk would be like putting trifle or blanc-mange into the quartz-crushing machine; it would merely put it out of gear. On the other hand, the child, the delicate woman, the dyspeptic, the invalid, have stomachs that may be compared to a light chocolate-crushing machine. Quartz they cannot crush, and the attempt would ruin the machine, although it may be perfectly equal to crushing light things, such as chocolate, eggs, etc.

In sickness and in deranged health the digestive organs lose their tone and powers, and should be treated as Nature treats the young; that is, the kind of nitrogenous food should be given which entails the least work on the part of the stomach. It is weakened, its muscular and secreting powers are diminished, and it no longer requires for its health many hours of rude exercise daily. The rule should be, therefore, to give it as much rest, on the contrary, as is consistent with the duty it has to perform—that of furnishing nutritive materials to the economy. This can only be done by supplying it with the kind of nitrogenous food which is the

easiest dissolved, and which takes the least time to transform into chyme. Such food, we have seen, is to be found in the fluid animal substances, milk, eggs, broths; and in those in which the muscular fibre is loosely aggregated, such as fish, fowl, and game. The convalescent and dyspeptic, generally speaking, digest this kind of food easier, and with less suffering, than meat; so much so that it constitutes the diet of the sick chamber.

Among the different kinds of meat, also, there are great differences. Lamb and mutton are easier digested, because less compact, less dense, than beef; and meat that has been kept until it is tender, that is, until its compactness and density have been chemically modified, is more easily digested than meat freshly killed.

It is this well-established fact, the easier digestibility of loosely-aggregated tissue, that has led me to repudiate raw meat in the diet of invalids. Cooking, the action of heat, dissociates organic tissues, destroys the cohesion of muscular fibres, and must, therefore, render all kinds of meat easier to dissolve, to digest. It is an experiment any one may make. We have only to boil or stew even recently-killed meat for a given number of hours, say six (boiled beef), to reduce it all but to the consistency of marrow. Continental cooks are well aware of this fact, and make the coarse meat they have to deal with savoury and tender by dint of boiling and stewing. To give meat raw, however

finely chopped, is to forego all the advantages gained by judicious cooking, and to force on the digestive organs double work. Moreover, raw, uncooked, meat may contain the ova of human entozoa, of the various species of tape worms, and of the trichina. Once introduced into the economy through food, these worms may penetrate into it, pervade every part of it, and destroy life in a very agonizing manner. Many have died, and do constantly die, from the ravages of the trichina in Germany, where the habit of eating raw pork, ham, and meat generally prevails. This habit has been introduced by the medical profession on what I consider most erroneous grounds, viz., the presumed easier digestibility of raw meat as compared with cooked. By thorough cooking these ova appear to be destroyed, so that the danger is avoided. All kinds of entozoa are exceedingly common in Eastern Europe, both among children and among adults, owing to the habit of eating raw meat in one shape or the other.

As we have already stated, most cooked vegetables, as also farinacea, bread, potatoes, rice, etc., are soon digested, and transformed into chyle; but as the quantity of nitrogen which they contain is small, they are only resorted to as adjuvants in the dietary of the dyspeptic or invalid. To feed an invalid entirely on vegetable food, so large a quantity must be taken that the bulk would, in most instances, overload and oppress the weakened powers of digestion. Moreover, much more carbon would

be ingested than is required for organic combustion, especially if the patient is protected from atmospheric influence. If the adipose tendency existed at all in the constitution, it might, also, lead to an over-abundant deposit of fat. This result of an over-abundant supply of carbonaceous food, purely nitrogenous food being at the same time withheld, is much less frequently observed in man than in animals. The latter are easily rendered adipose by over-feeding on carbonaceous food; whilst in man, to develop the adipose tendency, a mixed dietary seems, generally speaking, to be necessary. It would appear that, for fat to be formed from the carbon compounds ingested in man, it is absolutely necessary that the organic nutritive powers of the economy should be sustained by a moderate supply of nitrogenous food.

Uncooked vegetable substances, such as carrots, turnips, cucumbers, or unripe fruit, the texture of which is close and dense, are much more difficult of digestion than the same vegetables or fruits, softened by cooking or by ripeness. By reason of their density the gastric juice has a difficulty in dissolving them; thence partly their indigestibility.

Indeed, density of structure is evidently one of the principal conditions that regulate the digestibility of both animal and vegetable food. The dense kinds of meat, such as pork and beef, and hard vegetables, and fruits unsoftened by cooking, may be familiarly compared to cotton or hay com-

pressed by steam presses, for the facility of transport, until half-a-dozen bales or trusses are made to take the space of one. In such a comparison the less dense kinds of food would represent intermediate degrees. The cotton or hay packed so as to take one-sixth part of the ordinary space would, of course, resist any dissolving power at least twice as long as that which had been compressed to only half the extent.

An important element in regulating the dietary of the healthy, as well as that of the invalid, is change. It is all but absolutely necessary that the diet should be more or less varied, for the digestive processes to be easily and healthily performed. The only two substances which probably contain all the elements necessary for animal nutrition are milk and eggs; and they alone are merely fitted for the early stages of viviparous and oviparous life. At a later period of organic development, when taken *alone* by healthy individuals, they often appear to fatigue the digestive powers, to which they are evidently no longer suited as the sole nutritive element. Many experiments and accidental facts have proved the necessity of a varied diet, and the very decided craving of the appetite for variety in food points to the existence of an innate instinct in this direction.

As we have seen, the most delicate test of the perfect digestion of food, whatever its nature, is to be found in the examination of the urine some

hours after its ingestion. When food is properly digested, and the chyle, resulting from the processes of digestion, is assimilated, as is the case in normal nutrition, the urine remains clear, and free from all deposits, both when excreted and on cooling. When, on the contrary, the digestive process is defective, and the chyle imperfect, deposits take place, formed of urate of ammonia and of other morbid salts, which render the urine turbid on cooling. In the dyspeptic patient many causes, usually but little studied and appreciated, will disturb digestion, and be followed by this result.

The stomach and digestive organs generally may have the power to dissolve and chylify the lighter or less dense kinds of food, and those only. In such cases cooked vegetables, in moderate quantities, and the lighter animal substances, such as milk, eggs, fish, and fowl, may be thoroughly digested; as evidenced by the immunity from subsequent pain, sleeplessness, or suffering, and by the absence in the urine, passed a few hours afterwards, of the uric acid or of the turbid lithatic deposit. But if the more dense forms of food—mutton, or beef, or pork — be taken, the stomach often seems to refuse to perform the increased work demanded of it; flatulence, oppression, and acid eructations are experienced. The urine on examination, four or five hours after it is passed, is found to be loaded with the morbid salts; and, on cooling, becomes turbid, owing to a more or less abundant deposit of

urate of ammonia and soda. These facts ought to guide the observer in the choice of the food regimen.

It is worthy of remark, that pain and oppression, during the digestion of food, are not always the evidence of imperfect digestion. The stomachal elaboration of aliment may be laborious and painful, and yet complete; as evidenced by the absence of all deposit in the urine, which remains quite clear on cooling, and by the absence of the headache, want of sleep, loaded tongue, and other constitutional symptoms which nearly always follow disordered digestion.

On the other hand, the elaboration of food may be unattended with any pain or discomfort, and yet be most defective; as evidenced by a copious deposit of urate of ammonia, and of other morbid salts, from the urine, by the loss of sleep, and by the extreme constitutional distress which the patient subsequently experiences. This is often the case, both with the dyspeptic and with the healthy man, when more wine than usual has been taken with a meal. Although at the time all is *couleur de rose*, digestion is disturbed by the wine ingested in over-abundance. The chyle is imperfectly elaborated, and it is eventually, in great part, thrown out by the kidneys and liver, after poisoning the entire system as it passes through it.

Again, if the digestive system is one of those that require rest after the elaboration of food, and that rest is not given, it flags, does its work

imperfectly, turbid urate of ammonia loaded urine is voided, and the entire economy is disturbed. As I have elsewhere stated, many persons in perfect health present this peculiarity of the digestive system—they can only digest food thoroughly at long intervals; so that two meals, or three at the utmost, are all they require in the twenty-four hours. Unless they find out, discover, by experience, this peculiarity of their constitution, and conform to it, they inevitably become confirmed dyspeptics.

The urate of soda and ammonia test, the most delicate in my experience, is easily applied in such cases. Let those who suspect that such is their constitution, merely make a light breakfast at nine and an ordinary dinner at five for a few weeks, examining the urine three hours after breakfast, and four or five after dinner. They can then modify the experiment by making three or four meals a day—breakfast, lunch, dinner, and tea; or breakfast, dinner, tea, and supper. If they find that in the first case the urine remains free from turbidity and morbid deposits, whereas in the second it shows both, they may conclude that the first system suits them, and that the second does not; the converse is equally true. There is nothing to be said to the results obtained by such an experiment. They are formal, peremptory, and must be acquiesced in.

The simple investigation of the physical con-

dition of the urine on cooling, will also throw light on the individual caprices or idiosyncrasies of the digestive powers. These idiosyncrasies are infinite, and quite unreducible to any rule. Thus one person cannot properly digest the first meal, breakfast, unless it be taken immediately on rising, whilst another must be up and about for one or more hours, before the stomach is sufficiently roused to perfectly carry out the digestion of food. Again, one person can only digest the principal meal of the day when taken at mid-day—at one or two o'clock; if a later hour is chosen, faintness and loss of appetite ensue, and the meal is imperfectly elaborated. Whilst another has a fit of indigestion if the dinner is taken early, but can digest the identical meal with ease if the hour is four, five, six, seven, or even later. In recognizing and giving their due weight to these individual peculiarities, we must not forget that they are often the result of habits, early acquired, as elsewhere explained.

The above facts, which are deduced from the careful investigation, during many years, of the urine of large numbers of dyspeptic patients, show clearly that it is impossible to lay down general dietetic rules. Each case must be studied by itself, and the advice given must be modified according to the results of the study of each individual.

The existence of a lithatic deposit in the urine, a few hours after the ingestion of food, presents, however, in most cases of disordered digestion, an

easy means of arriving at the required knowledge. The circumstances of this salt rendering the urine turbid when it cools, makes it quite possible for the patient himself to carry on the investigation, once the physician has ascertained that the turbidity is owing to the presence of the lithatic deposit, and not to pus, etc. Thus, an Ariadne thread is placed in the hands of the dyspeptic patient, which may enable him, with some slight assistance from his medical attendant, in the way of explanation and direction, to guide his own path through the dietetic labyrinth. He may thus learn, to a certain extent, what kind of food suits him individually, what amount he can take, and at what intervals and hours it is required in his own particular case. Should, however, uric acid, oxalate of lime, or the triple phosphates be present with or without the urates, this information could, of course, only be obtained by microscopic examination.

The same mode of study may be applied to beverages, and their influence on digestion. If alcoholic stimulants are beneficial, they will not disturb digestion, and the urine will remain as clear, as free from morbid deposits, as if they had not been taken. But if, on the contrary, as sometimes occurs, even with the healthy, and very frequently with the weak and dyspeptic—beer, wine, or spirits, even when taken in moderation, render the urine turbid and lithatic, evidently disturbing digestion, they assuredly can do no good.

Indeed, far from doing good, they are a snare and a delusion owing to the temporary feelings of strength and comfort to which they give rise, at the very time they are, in reality, disturbing digestion and poisoning the economy.

Many persons, in perfect health, as we have already stated, may observe on themselves how alcoholic stimulants thus tend to disturb digestion, by noticing the state of their urine the morning after a dinner or festival, at which they have taken more wine than usual. They will often find it densely turbid, from a deposit of the double urates; the evident result of the disturbance of their digestion. occasioned by the unusual amount of food or stimulants ingested. What the extra quantity of stimulant taken does to them in health, a very much smaller amount may do in one whose digestive system is already weakened, and who is already suffering from dyspepsia or from some other kind of illness.

Tea and coffee, and all nerve stimulants of the same class, may likewise disturb digestion, and their use may be followed by lithatic urine, especially if they are taken in a very concentrated form. They are, however, undoubtedly less liable to produce this result than beer or wine, probably because their action is confined to the nervous system, and because they only slightly interfere with, or retard, the organic combustion of the chyle and of the products of molecular disintegration.

Coffee and tea afford but little nourishment to the

economy, but appear to have a peculiar power of arresting the molecular waste, and of thus diminishing the amount of nutritive materials required. Supposing the daily waste of the economy to be represented by thirty, under the influence of a fair supply of coffee or tea the waste might be reduced to twenty-five. If so, only five-sixths of the food usually required would be necessary; there would be a saving of one pound out of six. Thus is explained the desire of the poor for strong tea. It contains little nourishment, but prevents their wanting so much food; moreover, it is a powerful stimulant of the nervous system, and supplies the universal craving for stimulants, to which allusion has already been made.

We must not, however, lose sight of the fact that this artificial arrest of the molecular waste, of the normal and physiological disintegration of tissue, must be deleterious if carried far. It means artificially produced stagnation of the organic processes, and as such must be considered an interference with the functions of life. We have seen that the same influence, an arrest of molecular waste, an arrest of the normal oxidation of tissue, is produced by alcoholic beverages. The rational deduction is that none of these nerve stimulants, dietetic or alcoholic, can be taken in excess without compromising the vital functions, without danger to the organization.

All fluids which contain nutritive substances in

solution entail digestive labour on the stomach. Even water cannot be absorbed without rousing to a slight extent its functional activity. This fact is illustrated by the oppression, discomfort, and absolute pain which follow the ingestion of any fluid in many dyspeptic patients. The process of digestion is a painful one with them, whether it be solids or fluids that they have to digest and assimilate.

The deduction we may draw is, first, that pain after the ingestion of fluids should not prevent their being taken in sufficient quantity for the wants of the system—a mistake many dyspeptics make. Secondly, fluids should not be taken between meals, and more especially when the digestive process is accomplished, the stomach's rest being thereby disturbed.

A great error in diet is to take very cold or iced beverages during meals, especially in cold weather. As we have seen when speaking of stomachal digestion, the gastric juices only dissolve nitrogenous food at the temperature of the body, about 98°. Below that temperature the solution of such food is arrested. The ingestion of large quantities of cold or iced fluids must, therefore, retard digestion until the stomach has had time to warm them up to 98°; a long process with the weak, the sickly, and the aged. Thus, the duration of the stomachal digestion may be indefinitely prolonged, and in part or altogether depraved. This remark more especially applies to those who drink water or

weak wines. Strong alcoholic beverages draw blood in abundance to the coats of the stomach, which enables it sooner to warm its contents. I have cured many dyspeptics by making them always drink warm fluids at meals, especially Americans, who are nationally prone to fall into this dietetic error.

The rules laid down in the preceding pages for dietetic guidance in ill-health find their application in the management of sick children even more forcibly than with adults.

In our own country, the nursery management of children's diet is generally carried out on a sound basis. A morning breakfast of milk, bread, butter, eggs; a mid-day meal, or dinner, of meat, or fish, or fowl, not all three, with vegetables, and a light pudding, and with water as a beverage; a supper about six, as light as the breakfast, constitute a wholesome dietary with which no fault can be found. Nor do children rebel against it, until quite adolescents, provided they feed alone in the nursery. When they eat with their parents, as is generally the case on the Continent, they soon learn to repudiate the light, wholesome food suited to their age, and become clamorous for all their parents take or have on their table, as a natural and inevitable result of the force of example.

The common error lies in deviating from these sound rules when children are ill. They are then constantly plied, against their will, with heavy animalized food, with meat several times a day, instead of once; with

wine, Port and Sherry, instead of water; and all because they are ill, weak, sickly, without appetite. Nothing, in reality, could be more contrary to the dictates of common sense, more dangerous to the present and to the future, than such a course. It generally aggravates the child's ailments, by overpowering and impairing the digestive functions, instead of strengthening them. The really rational line of conduct is to remove disease, if feasible, to secure a hygienic life, including a country residence when attainable, and to let the dietary be even more simple than in health.

For the last eighteen years, during the winter months, I have seen a great deal of French and Continental practice at Mentone, where I reside, and I am distressed, every winter, to witness the mischief that over-feeding delicate children entails.

The French, and Continentals generally, have a light breakfast at eight or nine, and a second breakfast at twelve, in reality a regular dinner, dining again heartily at six or seven. There is no real nursery life, as we understand it; children, from three or four upwards, sitting down to meals with their parents, and going through all the courses. They thus make two heavy meat meals each day, the last just before going to bed, much to their detriment. I have restored many French children to health merely by depriving them of this last meal, and by substituting for it a milk and bread and butter supper.

One of the great disadvantages of children having their meals with their seniors is that they all but invariably take a dislike to milk, which, whenever attainable, ought to be one of the chief articles of diet during the first years of life. It was intended to be so by Nature, and it is difficult to rear human children in infancy without it. If the mother's milk fails, or is of bad quality, and its place cannot be supplied by the milk of animals, children, during infancy, die in a frightful ratio.

In the course of my travels, I have everywhere found that the want of milk-producing domestic animals exercises a very pernicious influence on the life of children, increasing their mortality, and thus keeping down population. Nowhere have I found this evil influence greater than in the island of Sardinia.

Owing to the insecurity of the country, and also to the idea that towns are healthier than the country, where malaria often reigns, the agricultural population of Sardinia is all but universally cooped up in towns and large villages, and hence a paucity of milk-giving cattle, which obliges the infants to depend entirely on their mothers, the latter being often underfed and weakened by fever. The result is that not more than two out of ten, I was told, are reared. Moreover, these imperfectly-fed children are so delicate that they cannot resist adverse influences. In 1873, there was an epidemic of diphtheria at Cagliari, the capital, a town of 30,000 inha-

bitants, and 800 children died! Of these 30,000 inhabitants 20,000 are agricultural labourers, without cattle of any kind. In my work on the climate of the Mediterranean, p. 464, I remark:—"Such is the result of cooping up an agricultural population in towns and in large villages, without milk-producing animals for the children to feed on. During the first year of a child's life its very existence depends on its obtaining milk from some source or other. Thus also is partly explained the depressed state of agriculture, and the falling off of the population of Sardinia, everywhere observed and lamented."*

On concluding this chapter, I would recall the physiological facts that man is more frugivorous and herbivorous than carnivorous. From three to five ounces of flesh-formers, or nitrogenous compounds, suffice, in the twenty-four hours, for his nutrition, whereas from ten to twenty ounces of heat- and force-producers, or carbonaceous compounds, are required. In ill-health this should never be forgotten; and yet, as we have seen, the important fact is constantly forgotten or ignored. The vain and irrational attempt is made to remedy debility and illness by increasing, indefinitely, the quantity of nitrogenous food, although it can no longer be properly digested.

* "Winter and Spring on the Shores and Islands of the Mediterranean." 5th edition.

CHAPTER VIII.

CONFIRMED DYSPEPSIA.

We have spoken, hitherto, of the cases in which the urine is not constantly loaded with morbid salts after food, and in which, by the exercise of care and discrimination, by attention to the quality, quantity, and periodicity of food, its digestion can be secured without the formation of imperfect chyle, without the elimination of an excess of urate of ammonia by the kidneys, and of imperfectly-elaborated bile by the liver, with the concomitant tendency to bilious attacks. In the confirmed dyspeptic, however, and in the patient suffering from stomach disease, or in whom the digestive and nutritive functions generally are weakened by the sympathetic reaction of other diseases, the urine may be *always* lithatic after food, whatever its nature. The urine may even be lithatic when there is no food in the economy.

When this occurs, we have no longer the guide afforded by the occasional presence of morbid salts in the urine, the result of dietetic errors with regard

to the quality or quantity of food, or the hours and frequency of meals. We have no longer merely to guard against errors which the study of the individual case reveals, and enables us to remedy; for the urine is constantly loaded with these salts. Both reason and experience, however, show that the same rules apply to these cases that apply to minor forms of nutritive derangement; only these rules must be applied with much greater rigour and perseverance.

In such cases, more especially when the stomach is diseased or weakened, its secretions depraved or deficient, and its muscular powers diminished, it is most irrational to keep it at work the greater part of the twenty-four hours, under the absurd assumption that it ought not to be left empty. It would be as rational to keep a man with a sprained knee or ankle constantly walking, in order to strengthen the joint. In fact, the great drawback to the recovery of a patient whose stomach and digestive system are permanently out of order is, that the organs *must* be kept at work, or the economy would waste and perish, so that complete rest of the weakened organs is simply impossible. The object of the physician, in such cases, ought to be to regulate the dietary so as to attain the ends of nutrition with as little vital and muscular effort to the stomach as possible.

In pursuance of this view, food should only be taken two, three, or four times in the twenty-four

hours, according to the age, sex, and constitution. Children require food oftener than women; women oftener than men; the young and old generally oftener than the middle-aged. The food itself should be of a kind calculated to afford the principal elements of nutrition—nitrogen and carbon, with the least possible amount of digestive labour. Thus meals in which milk, eggs, butter, gravy soups, fish, fowl, game, cooked vegetables, and well-fermented bread form the principal ingredients, only give the stomach two hours' or from two to three hours' work. Yet they contain nitrogenous elements in abundance, although not perhaps in as great abundance as if the dietary were mutton, beef, or veal. Thus, a breakfast of weak tea, coffee, or cocoa, made with plenty of milk, if the stomach will bear it, with bread, or toast and butter, and one, two, or three eggs; a mid-day dinner, of fish, or fowl, or game, or mutton in moderate quantity, with a little gravy soup, if it agrees, and vegetables, or a bread-and-butter or rice pudding, in order to make up in quantity, when the appetite is good; and a tea supper at six or seven, consisting of weak tea, with or without an egg or two, and bread and butter, will afford the economy all the nutritive materials it can possibly require under ordinary circumstances.

Such a dietary, at the same time, only represents about seven hours' work for the stomach. The digestive organs will thus have seventeen hours' rest to recover themselves. To many, breakfast at nine,

and dinner at four, five, or six, with or without a cup of tea or cocoa in the evening, prove sufficient. If so, it is for them the best system, as the economy is then nourished with five hours' stomach work, and nineteen hours are left for rest. It is worthy of remark, that in the early stages of life, when the craving for food is great, the night sleep is very prolonged, generally lasting from ten to twelve hours, so that a long rest is afforded to the highly vitalized digestive system. Milk may replace the tea.

Whether dinner is taken early, and tea late, or a light luncheon is taken at mid-day, and the dinner is late, some dyspeptic persons really cannot sleep, unless food is ingested the last thing. In such cases, a basin of gruel, or sago, or arrowroot, or a little bread and milk is all that should be allowed, until the habit can be got rid of; light food of this description being soon digested. A heavy night meal, or even a light one of solid food, necessarily entails hours of labour on the stomach, and that when it is weary with the day's work. Thence its frequent rebellion, and the sequel: restless sleep, painful dreams, and nightmare, from indigestion.

The very late dinners of fashionable life are often followed by these results; for they are in reality suppers. Were those who partake of them merely to make a light mid-day meal, they would not be quite so objectionable. But as it is difficult to wait until so late an hour for the principal meal of the day, very many persons have a

hot lunch, and in that case they really dine twice, the late dinner being in reality a heavy supper. To the dyspeptic such a regimen is perfectly poisonous, and the strong and robust often succumb to its injurious effects, and become confirmed dyspeptics.

In Continental and American town life the same remark applies. The rule is to take coffee with a small roll at eight, a second breakfast, *à la fourchette*, at eleven or twelve, and dinner at six or seven. The second breakfast, in well-to-do houses, becomes a regular dinner, without soup; so that two dinners, two full meals of animal food, are taken. This plan agrees with some, but overtaxes the digestive system of many, and leads to confirmed dyspepsia. An eminent French physician, Chomel, states, in a work on "La dyspepsie acescente," which he wrote on his death-bed, that four out of five of the Parisians who came to him in his consulting-room were suffering from morbid conditions, attributable to this twelve o'clock breakfast, or real dinner.

It is interesting to observe that these Continental food habits have a religious origin. Both our English word break-fast and the French word dejeuner imply that the meal was the breaking of the fast, after mass. It was considered unorthodox to attend mass after eating, so the first meal was really the break-fast. Up to this day the Roman Catholic clergy celebrate the early mass fasting, and with their flock the cup of coffee is merely a concession to the lateness of modern religious observances.

This custom of taking the real morning meal as late as eleven or twelve o'clock is clearly not physiological or rational. After the long interval of the night, the food supplies must be pretty nearly, if not entirely, used up, exhausted. The principal meal of the early part of the day, which is intended to supply the economy with elements of nutrition urgently required, should be taken soon after rising, say at eight, nine, or ten o'clock, according to habits. To take coffee only is merely to stave off the required meal by a nerve stimulant, which deceives the economy, lulls it, takes away appetite by arresting disintegration of tissue, but does not satisfy its cravings.

I often familiarly compare the human economy to a kitchen fire, banked up with coal overnight, in winter. In the morning all this coal has been consumed, and the fire requires replenishing. A bundle of small wood (coffee) would make a blaze for a few minutes, but it would not remake a good roasting fire; for that an ample supply of coal is wanted.

When the attempt is made, in accordance with the above views, to afford the stomach as much rest as is consistent with the nutrition of the economy, by giving easily-digested food, and at intervals as distant as possible, we must take care that enough of the elements of nutrition are ingested to satisfy the requirements of the economy. To secure this it is well for the patient to be weighed once a fortnight, if possible, in the dressing-room, with light

clothes, or even without any. Thus we ascertain to an ounce whether he or she is losing or gaining ground, or remaining *in statu quo*, and we can regulate the amount of food accordingly. As long as there is no loss in weight, we have unmistakable evidence that the food supply is equal to the nutritive demands of the economy, however moderate the former may be. If, on the contrary, there is a loss of weight, it is equally evident that the supply of food is not equal to the nutritive demands, or that a due amount of nourishment is not extracted from it, and it may become advisable to increase the amount. Unless, however, the loss were at the expense of an accumulation of fat, which we wish to diminish or to get rid of.

Stoutness from the deposit of fat may exist in the confirmed dyspeptic invalid, and its diminution is a positive advantage when its presence is thus carried to an excess. As we have seen, the deposit of fat can only be remedied with safety by reducing the supply of carbonaceous food below the requirements of the economy, at the same time that the functions of organic life are rendered more active. Thus sleep should be reduced to the amount strictly necessary—eight or, at the utmost, nine hours, the muscular system should be brought into active play by exercise, which increases organic combustion, and a slightly insufficient amount of carbonaceous food should be given. To meet the increased requirements of the organization, which

the food consumed does not entirely supply, the fat deposited throughout the body is thus gradually absorbed. We must, however, as I have elsewhere stated, never attempt to progress too energetically in this direction, lest we should weaken the organization by thus forcing it to feed too rapidly on itself, owing to insufficient supply of the materials of nutrition. A diminution of weight amounting to half a pound or a pound a month is as much as it is prudent to obtain, especially in the case of an invalid.

The same result may, in healthy people, be attained by exercise and exposure to the atmosphere, without diminishing the dietary. It is, however, only to be secured by an amount of exercise which is, generally speaking, quite incompatible with the diminished muscular strength of debilitated dyspeptics. Walking with them can only be carried to one, two, or three miles daily; riding, to five or six. Even that moderate amount of exercise may be an impossibility, may be followed by palpitation, exhaustion, and a total inability to eat or to digest. We are then thrown back upon diet as almost the only means of reducing the fat deposit.

In some such cases, however, I have succeeded in rendering a certain amount of exercise bearable by making my patients walk for five minutes every hour or half hour, with intervals of rest.

My experience in the treatment of even invalids presenting general fat deposits as a complication of disease has led me to the conviction that this con-

dition of the system may be remedied, and the tendency may be controlled, in most instances, with perfect safety to the individual, by the above means. There is, however, as already stated, scarcely one person in fifty who will submit to the constant self-sacrifice and discipline which is implied by conforming to the principles laid down. These principles may be recapitulated in a few words: daily exercise carried as far as is consistent with the strength of the individual, care being taken not to produce exhaustion; abstinence, total or all but total, from alcoholic stimulants; and the reduction of food, especially of carbonaceous food, to such an extent as to be attended with the slow but constant diminution of the weight, as tested by the scales,—all other tests being delusive.

The difference in the nutritive powers of healthy individuals, or of their capacity of extracting nourishment from the same food, is so very great that it is vain to attempt to lay down any limit as regards the amount of food that will merely supply wear and tear and organic combustion, and that which will, in addition, allow of the formation and deposit of fat. One person will thrive and grow fat on what would starve another, and soon produce emaciation. It is, indeed, only by weighing the person under study at short intervals that we can ascertain the quantity individually required. This observation applies equally to those whose digestive functions are chronically disordered.

From what precedes it is evident that it is by no means requisite for an individual, dyspeptic or not, to be a large eater, to grow fat and corpulent; although I firmly believe that all those who have become so either are or have been endowed with a good appetite, which they have gratified for a longer or shorter period. I have always found that stout people with whom I have lived have good appetites, and eat well.

In my consulting-room I have often been told by excessively stout persons, that they eat "like a bird." When such a statement is made the thought always occurs to me that there are birds and birds—sparrows and ostriches!

We have seen, when speaking of the tendency to the formation of fat in healthy persons, that its existence is often one of the most prominent symptoms of depraved digestion, of confirmed dyspepsia. Indeed, it is more especially among confirmed dyspeptics that large deposits of fat take place without over-feeding.

At the risk of repetition, I would recall the fact that a small amount of carbonaceous food, in addition to what the economy requires, will create half an ounce of fat a day. A glass of beer, a piece of bread, a little light pudding, more than is wanted for normal nutrition, will amply suffice. Half an ounce a day is a pound a month, and a pound a month is nearly a stone a year. Now, two or three stones added to ten or eleven make all

the difference between spareness and corpulence. That a very small amount of surplus carbonaceous food should be followed by fatness, when the constitutional tendency exists, or when the digestive and nutritive powers are weakened, is not surprising, if we consider that the greater part of the food we daily consume is transformed into chyle, and ought to be used in the nutritive processes. The alvine evacuations, as we have seen, do not amount to more than four or five ounces in a healthy man, physiologically but not overabundantly fed. If, therefore, more chyle is formed than is required for the purposes of assimilation and organic combustion, is it surprising that the carbonaceous element, which has not, perhaps, so ready a vent in the liver as the nitrogenous has in the kidney, should be deposited throughout the economy in the shape of fat?

When the diet is diminished, with the view of reducing fat deposits, the diminution must necessarily bear principally on the carbonaceous element, both with the healthy and with the dyspeptic, and that is much better done by striking off one meal entirely than by avoiding this or that article of food. The patient must not also fall into the error of increasing the supply of nitrogenous food, because he takes less of the carbonaceous; for all animal food contains carbon, as nearly all vegetable food contains nitrogen.

In regulating the dietary of those who are suffer-

ing from defective digestion and defective nutrition in a confirmed and chronic stage, the question of the advantage or disadvantage of alcoholic beverages occupies a prominent position, and requires careful elucidation. The debility and languor which usually exist in such cases as a painful reality, and which are the immediate result of the defective elaboration of nutritive elements, are, *for the time*, remedied by alcoholic stimulants. Wine, malt liquors, brandy, spirits, stimulate the nervous system of the weak or dyspeptic patient, and give for a short period artificial strength. They who can neither think nor act, whose brain is clouded, and whose muscles are powerless, recover under their influence, temporarily, the deficient mental and bodily energy.

No materials, however, for the repair of wasted tissue have been afforded—or, at least, none which the economy can or will use; and once the influence of the nervous stimulation has been exhausted, a collapse generally follows, and the debility and languor are greater than ever. This is a law of nature; all artificial stimulation is followed by a proportionate exhaustion of the function stimulated. Under the influence of the excitation of the brain which accompanies the delirium of fever, the wasted patient summons to his aid muscular power sufficient to try the strength of half-a-dozen persons. But when the fever and delirium have subsided, collapse follows; he can

then scarcely raise his hand from the bed, and a child could hold him.

Such strength as that which alcoholic beverages give to the weakened dyspeptic is a mere delusion, which does harm in many ways. On the one hand, it exhausts the remaining vital power of the organization, without any commensurate advantage. On the other, it deceives both the patient and his medical adviser—the patient, by endowing him for a time with powers which he has not in reality, thus masking his real condition; the physician, by persuading him that he has really given strength, when he has only stimulated the nervous system. In a word, if the patient is exhausted, weak, debilitated, unable to go through the duties of life, it is much better that this, the real state of the economy, should be recognized and accepted, and its causes struggled with, conscientiously and scientifically, than that his condition should be obscured by any kind of alcoholic stimulant.

Perhaps the greatest real advantage which a person debilitated by defective digestion and nutrition derives from alcoholic beverages is, that they assist in the generation of heat. The economy will burn alcohol when it can with difficulty burn imperfectly-formed chyle, or when chyle is not generated in sufficient quantity to supply the demand for organic fuel. It is partly because this is the case that the ingestion of alcoholic fluids is attended, as we have stated, with the sensation of an agreeable glow,

which pervades the entire economy, and is followed by great apparent comfort and relief.

Were this relief unattended with any serious drawback, alcoholic beverages would really be a sheet-anchor in the treatment of defective nutrition; but such, unfortunately, is not the case. There is a drawback of a very serious nature, which has been already explained, viz., the arrest of destructive metamorphosis, and the interference with the organic combustion of the products of molecular disintegration, and with the formation of protein compounds in the blood. The blood, as we have already seen, thus becomes loaded with effete carbonaceous and nitrogenous elements, which the natural emunctories have great difficulty in removing.

Moreover, observation has proved to me and to others that the direct influence of the alcoholic element on the organs of digestion in the confirmed dyspeptic is often pernicious, probably through the over-stimulation and irritation which it produces on organs already disordered and suffering. This rule, in my experience, suffers but very few exceptions. The exhibition of alcoholic beverages appears to me very frequently to aggravate the deranged state of the digestive organs, to increase the formation of lithatic and other morbid salts in the urine, and to perpetuate their presence. So convinced am I of this fact, that I have no hesitation in saying that most of those whose urine is invariably turbid after the digestion of food, are better without alcoholic

stimulants of any description, until their digestion has been restored to a normal state. A concession may be made to extreme debility, to previous habits, to preconceived ideas, or to the prejudices of those who surround the patient; but with a few exceptions, belonging to the first categories, the concession is merely damaging to the patient, and makes the recovery only the more tedious.

When, at last, the digestive functions are rallying—when more exercise, more exertion, more exposure to atmospheric vicissitudes, becomes possible and desirable, and the urine clears after food—the indications change. The nutritive and heat-generating requirements necessarily increase, and a limited amount of alcoholic stimulant, in the shape of wine or beer, may be given, in order to afford the necessary supply of carbon, without overloading the stomach with food. The less alcoholic wines, taken with water, or beer diluted with water or with soda-water, are most suitable. But this change should be made very cautiously; the state of the urine should be watched, and on the slightest reappearance of the turbidity occasioned by the morbid salts, the patient should return to water as the beverage.

We may therefore say that, as a rule, the confirmed dyspeptic should be all but a water-drinker, until he has recovered his health. As we stated in the first part of this work, it is the robust and the strong, who have to bear the active duties, the fatigue and exposure of ordinary life, who can,

not only with impunity but with positive advantage, consume alcoholic beverages. The weak and the debilitated, when the cause of their debility is disordered digestive power, are, in very many cases, better without them, if they wish to get well, and not merely to pass from one day to another by the aid of an artificial stimulus.

Such a stimulus, although it gives apparent strength, may in reality produce positive injury, and render the epoch of recovery more and more distant. What should we say of a surgeon who handed crutches to a patient complaining of lameness, as a remedy for his ailment? Should we not feel that his duty to his patient would be better performed were he to examine into his real state, to see whence his lameness proceeded, and to treat the cause before he advised the crutches? And yet, such is the line of conduct of the practitioner who advises stimulants to a dyspeptic patient because he is weak. The sufferer had better feel weak than gain temporary strength by means which only lead to a greater collapse, and to an exaggeration of the cause of his weakness. He had better be cold and chilly, and seek a remedy in artificial warmth and clothing, than gain it temporarily by agencies which increase the digestive disorder—the real cause of his chilliness.

The remarks made respecting the non-alcoholic stimulants, coffee, tea, etc., when speaking of the occasional dyspeptic, are still more applicable with a confirmed sufferer. As usually taken they are

not well borne by those who are labouring under chronic derangement of the digestive organs; they appear to stimulate too powerfully the local and general nervous system, producing spasms and heartburn, and their ingestion is often followed by an increase in the morbid urinary deposits.

At the same time, even when indiscreetly taken, they are infinitely less pernicious than alcoholic beverages. They neither stimulate nor excite the nervous system, nor do they interfere with the organic combustion of the elements furnished by molecular disintegration, to the same extent. Very diluted weak tea, such as would be given to a child three or four years old, and equally weak coffee, or milk flavoured with coffee, as taken on the Continent—weak *café au lait*—have not appeared to me, generally speaking, to exercise any perceptibly pernicious influence. On the other hand, the slight stimulus afforded by tea or coffee, even thus diluted, is often very grateful to the dyspeptic patient, and its administration solves a difficulty in dietetics, by affording an agreeable and yet innocent beverage for the morning and evening meal.

In dyspepsia, and especially in the more confirmed forms, the ingestion of fluids is not unfrequently as painful as that of solids. It is, therefore, refrained from as much as possible, which is a great error. Fluid, as we have explained, is absolutely necessary for the requirements of the economy, and must be taken to a physiological extent, that is, to the amount of two or three pints in the twenty-four hours.

I have often observed, especially when the intervals between meals are long, that half a pint of fluid, plain water, Seltzer, Vals or Vichy water, weak tea, indeed any bland fluid, will secure the digestion of the food taken afterwards. Probably it acts by supplying the necessary amount of fluid to the secretory organs, salivary, gastric, and pancreatic. The fluid may be taken tepid.

If we analyze the fundamental laws of hygiene, we shall find that they are all subservient to perfect nutrition—indeed, inseparably connected with it. The oxygen we extract from the atmosphere during respiration is as much food as the flesh and farinacea which we introduce into the stomach, and the purposes it has to fulfil are equally important. If possible, they are more so; for the introduction of oxygen into the animal economy begins with the first "breath of life," and continues unceasingly until death closes the scene. Moreover, the oxygen introduced into the system, as we have seen, not only combines with the elements of food to construct, to build up the tissues of the economy; it also combines with them in other proportions during their disintegration and elimination—when, having served their time, they die, and are thrown out. Thence the absolute necessity of an abundant supply of pure atmospheric air. For want of it nutrition *must* flag; for, on the one hand, the construction of new tissues is defective, and on the other, the elimination of those that are worn out is imperfect.

The most strict attention to the dietetic rules laid down in the preceding pages, and the complete removal of any co-existing disease, often fail to restore digestive and nutritive power, if the laws of hygiene are neglected. Plenty of pure atmospheric air to breathe, regular exercise of the muscular system, adapted in amount to the strength of the individual, a sufficiency of sleep at regular and proper times, and cleanliness of the skin, are essential requisites. Their entire or partial neglect is a serious and often unsuspected obstacle to the recovery of nutritive health.

In country life the supply of what may be termed atmospheric food (oxygenous) is, generally speaking, much more abundant than in town life, owing to the habits of those who make it their residence. More time is spent in the open air, and the habitations are generally more spacious and airy; even a farm-labourer has a cottage to himself. He is not, with his wife and children, huddled into a hermetically closed room a few feet square, as is the case with the majority of town artisans. Consequently organic nutrition with him is more perfect; he inspires more oxygenous food, and the processes of digestion and nutrition are more perfectly carried on. Like a lamp or a fire in a well-ventilated room, his economy burns brightly and vigorously.

It is a common idea that in the country, far from the influence of large towns, and especially in

mountain regions, we find a more highly oxygenized atmosphere, and that this is the cause of its greater salubrity; this, however, is an error. The oxygen of the atmosphere is in a state of mixture with the nitrogen and carbon, in conformity with the law of the diffusion of gases, and in the open air is always found in the same proportion. Thus, whether examined in Shoreditch or on the top of Snowdon, 21 per cent. of oxygen by measure only will be found combined with 79 of nitrogen; neither more nor less in either locality. The superior salubrity of the mountain air is derived, not from its containing more oxygen, but from its being free from the gases and emanations which towns and low marsh lands create and disseminate. The greater freedom also with which the atmosphere circulates and plays round the frame in elevated spots, contributes no doubt to the beneficial effects which mountain air appears to produce.

Although the chemical composition of the atmosphere out of doors, as far as the presence of oxygen is concerned, is pretty nearly the same in town and in country, the habits and occupations of citizens expose them much more frequently and continuously to breathe an imperfectly-oxygenized atmosphere. When the air of a room imperfectly ventilated is breathed by one or more human beings, it is rapidly deteriorated. On the one hand, oxygen is abstracted by respiration, on the other carbonic acid is emitted, and thus the air is rendered doubly deleterious. Its

vivifying, vitalizing element is diminished; and a deleterious, poisonous ingredient is generated. The influence of artificial light—candles, lamp, and gas—and of fires, is the same; oxygen is consumed, carbonic acid is emitted. Thus is explained the noxious influence exercised by crowded rooms, by the massing of workpeople in badly-ventilated localities, by that of the members of a family in one small room, and by want of ventilation under any circumstance in town or country, where animal life and combustion are deteriorating the atmosphere.

Dr. Angus Smith, in his work on "Air and Rain," has given a very interesting table, containing the results of his examination of the air of various places of public entertainment in London, which I subjoin:—

CARBONIC ACID IN CLOSE PLACES IN LONDON, ACCORDING TO DR. ANGUS SMITH.—NORMAL AMOUNT, 4 OR 5 PARTS IN 10,000.

1864.	Parts in 10,000 of Air.
Chancery Court, 7 ft. from ground, closed doors, March 3	19·3
Same, 3 ft. from ground	20·3
Same, door wide open	5·0
Strand Theatre, gallery, 10 P.M.	10·1
Surrey Theatre, boxes, 10 P.M.	11·1
,, ,, ,, 12 P.M.	21·8
Olympic, 11.30 P.M.	8·17
,, 11.55.	10·14
Victoria Theatre, boxes, 10 P.M.	12·6
Haymarket, dress circle, 11.30 P.M.	7·57
Victoria Theatre, boxes, April 4	7·6
City of London Theatre, pit, 11.15 P.M.	25·2
Standard Theatre, pit, 11 P.M.	32·0

1864.	Parts in 10,000 of Air.
St. Thomas's Hospital, Mercer's Ward, 3.25 P.M.	4·0
,, ,, Edwards' Ward, 3.35 P.M.	5·2
St. Luke's, Chelsea	7·6
East London, Homerton	7·6

ANALYSIS MADE IN APRIL, 1874.

Covent Garden Theatre, amphitheatre	22·0
,, ,, ,, near an open door, 10.10 P.M.	17·6
,, ,, ,, near a ventilator, 10.20 P.M.	14·8
Drury Lane, in the lower gallery	27·0
Money Order Office	17·4

It will be seen that in some of these theatres, the amount of carbonic acid was as much as 25 and 32 per cent., instead of four or five, the normal amount. Is it surprising that after spending four or five hours in such an atmosphere, the more delicate members of the audience should feel ill, faint, and leave with headaches which persist the next day? Is it surprising that they should catch inflammatory colds on leaving this heated poisonous atmosphere, often for a cold damp atmosphere? Such, too, is the condition of most churches, concert rooms, and crowded assemblies.

Indeed, even in the country, an atmosphere really pestilential, calculated to produce typhoid fever, or any other disease of that category, may be produced by the want of proper ventilation. This condition may be produced in a palace, simply by closing the windows, doors, and grate of the room in which many hours are passed. In many airy, healthy

houses, bed-rooms are rendered all but pestilential by the hermetic closure of every cranny by which air can enter. If one or two people sleep in a small carpeted room, with the door and window hermetically closed, and the chimney stopped up to prevent draughts, how can they expect to sleep soundly, and awake refreshed? They have very soon consumed all the air in the room; all ingress is closed to a fresh supply, and they then begin to undergo a course of slow poisoning from the air they have themselves contaminated. Thus the infringement of an important hygienic law may inflict the same penalty on the inhabitant of the luxurious palace, and on the half-starved inmate of an Irish cabin.

I have many a time discovered that the morning headache and lassitude of a patient was owing to this cause, and have found it disappear simply by leaving the bed-room door ajar, by opening the window half an inch, above and below, or by merely throwing open the grate. It is worthy of remark, that the wide open chimneys of our ancestors, through which you could often see the sky, were much more hygienic than our more comfortable register stoves; they were really ventilating shafts. In modern houses the only real and efficient ventilation is an open window in fine weather, an open door in bad, and that day and night.

It is said, I know not with what truth, that poisonous serpents, rattle-snakes, cobras, can poison themselves with their own venom, by biting their own

tails! This is really what those do who sleep in badly ventilated rooms. They poison themselves with their own emanations.

Town life has another disadvantage. It withdraws those who adopt it from the influence of daylight and sunshine, and that in two ways. First, town occupations are mostly carried on indoors and in the shade; secondly, the occupations and pleasures of life are carried into the night, and sleep is continued, to a great extent, into daylight.

It has been an axiom from time immemorial that, for health, sleep should be taken during the still hours of night, and not during the day. The example of the ruddy, healthy peasant, who retires to rest with his cattle, and is up with the lark, has been quoted a thousand times. It appears to me, however, that the undeniable fact of exposure to the light of day being an element of health, which vivifies and reddens the blood, was never satisfactorily explained until the publication of the experiments of the late Dr. Edward Smith, of the Brompton Hospital. Dr. Smith has proved that light is a powerful stimulus to respiration; that under the influence of daylight one-third more atmospheric air enters the lungs than under darkness, or even under exposure to artificial light. In other words, if in daylight, during a given time, six hundred cubic inches of atmospheric air were inspired, during the same time at night only four hundred would enter the lungs; a powerful addi-

tional reason and argument for pure air at night during sleep.

As the oxygenation and subsequent reddening of the blood depend on its contact with atmospheric air in the lungs during respiration, it is clear, if we accept the above statements, that the more the body is exposed to sunlight the more oxygen it will imbibe. As a necessary sequel, the more oxygen physiologically enters the economy, through the functions of respiration, the more perfectly will all the vital processes which require oxygen be performed.

Thus is satisfactorily explained the fact which we daily witness—the pallidness of the inhabitants of cities, who live constantly in shaded rooms and streets, and who sit up late and get up late. Not only do they spend their lives in habitations shaded from the vivifying rays of the sun, but they turn night into day, carrying their avocations, studies, or pleasures into the night, when respiration is imperfectly performed. When asleep even, they remain in darkened shutter-closed rooms until the sun is high on the horizon; thus prolonging the period of imperfect respiration.

The climax of this anti-hygienic arrangement of life is seen in the female votaries of fashionable society, who, night after night, only retire to slumber in a darkened room when the sun has already cast his vivifying rays on the face of nature. Can we be surprised that the lily should take the

place of the rose on their complexions, that languor of the vital functions should follow, and that tubercular deposits and other fell diseases should invade their half-vitalized economies?

Sleep, to be sound and refreshing, should be regular in its periodicity. We are the creatures of habit to a very great extent; all our functions have a tendency to settle down into periodicity, and it is vain to attempt to strive against what is a law of nature. The invalid, therefore, who is more especially bound to do all in his power to second the efforts of nature, should always retire to rest at the same hour. He should also rise at the same hour, taking every night the same amount of rest—from eight to nine or ten hours, according to age, sex, constitution, and strength.

Next in importance among hygienic laws is regular exercise, the value of which cannot be overrated. Man is not merely made up of respiratory and digestive or nutritive organs, he is also endowed with muscles—organs of locomotion and action, destined to carry him from one place to the other and to execute his will in a thousand ways. The healthy state of the muscular system, which is inseparably mixed up with that of the organic, can only be kept up by muscular exercise. Exercise implies organic change, waste, and reconstruction, as we have seen; and organic change, we know, is indispensable for organic health. How rapid that change must be will become at once apparent if we

consider the immediate results of exercise—of walking, for instance. In a mile there are 5,280 feet, and in walking a mile there are nearly that number of steps taken. In every step we take there is contraction, directly or indirectly, of some scores of muscles, indeed of a large proportion of the muscles of the economy. Thus, in a four-mile walk, these muscles must contract between fifteen and twenty thousand times.

As these contractions are known to be attended with destruction of muscular fibre, which has to be repaired, some idea may be formed of the vast amount of organic waste and subsequent repair entailed upon the economy by an ordinary walk. If the exercise is regularly repeated every day, it becomes evident that the organic vital activity of the muscular system must be wonderfully vitalized and accelerated, to the infinite advantage of the entire economy.

These physiological effects explain the prostration of an invalid, or, indeed, of any one unaccustomed to exercise, after a great muscular effort. They feel languid and exhausted, have pains in the muscles, and cannot sleep. They have used up, wasted part of their muscular structures, and there is not sufficient organic activity in the economy to rapidly renew the destroyed fibre; so the feeling of fatigue and prostration lasts. This, however, is not a reason for renouncing exercise as an impossibility, as not agreeing with the constitution. A small amount

only should be taken regularly at first, persevered in whether agreeable or not, and gradually increased, as the muscular power increases, which it is sure to do. I have found Payne's pedometer a most valuable aid. It marks, with great accuracy, the distance walked, so that the invalid can measure, to a hundred yards, the extent of his perambulations, although he vary them to any extent. Now that the patent has expired it is to be had of most watchmakers at a very reasonable price.

The amount of habitual exercise that can be taken, either by a healthy person or by an invalid, may be ascertained in two ways. Firstly, the fatigue or lassitude experienced ought to disappear after a few hours' rest, or, at all events, the next day. Secondly, the digestive functions ought not to be interfered with. The appetite for the next meal ought not to be destroyed, as with an overdriven horse, "off his food," as the groom says. The food taken, even when the appetite is not destroyed, ought to be thoroughly digested. The urine passed a few hours after ought not to become lithatic, turbid, on cooling.

The use of the pedometer for a few days casts singular and interesting light on the physiological results of habits. Active people, even in-doors, take a great deal of exercise. They are ever on the move, running upstairs or down, fetching all they want, and waiting both on themselves and on others; and that even when surrounded by domestics. Such persons, on wearing the pedometer, find that they

have walked several miles in the course of the day, without even leaving the house. This is the history of female servants, who often never go out of doors from week's end to week's end, and yet usually retain good health.

Sedentary people, on the contrary, persons of indolent habits, who never move from the chair or the sofa, if they can help it, and who ring the bell for all they want, reach the end of the day with scarcely a mile indicated on the tell-tale dial of the silent monitor. Not only, therefore, do they eschew exercise out-of-doors, but they do not even take it in-doors. Is it surprising that they should grow obese and unwieldy, and a prey to the diseases of a torpid, sluggish vitality?

In some form of dyspeptic suffering, in uterine disease for instance, there is concomitant disease which renders walking exercise impossible, or nearly so. Such a condition is a serious and unfortunate complication. When it exists, the patient should go out daily, if possible, in an open carriage or in a bath chair, and in summer sit as much as possible out-of-doors in the open air and at sun-lit windows. All such invalids should, in a word, seize every opportunity to take "sun-and-air baths."

Material benefit is to be obtained in confirmed dyspepsia by strict attention to the hygiene of the skin, itself an important emunctory organ, which, as we have seen, assists both the liver and the kidneys in purifying the blood of carbon and nitro-

gen. The entire body should be well washed with soap and water once a week at the least, and then well rubbed with a coarse towel or with camel hair gloves. When possible, and the state of the patient admits of the remedy, a tepid or cold sponging bath, or shower bath, between 60° and 70° Fah., should also be used daily, and friction subsequently resorted to. The pores of the skin are thus kept open, and the cutaneous circulation is tonified. The amount of fluid evaporated in the twenty-four hours is $1\frac{5}{7}$ lb.

We have a marked illustration of the beneficial effects, in chronic dyspepsia, of combining strict attention to diet and hygiene with cold ablutions, in the success which very often follows this treatment in hydropathic establishments. In these institutions the inmates are obliged to retire to rest at ten, and to rise early, are debarred from all stimulants, and restricted to the lightest and simplest food. They are encouraged in every way to take regular exercise in a pure atmosphere, in the midst of interesting scenery; they are removed from the cares and anxieties of their usual life; and, lastly, are submitted to a course of ablutions and water-treatment, which, if not carried to excess, promotes the healthy action of the cutaneous functions. Is it surprising that many, in whose home-life every possible hygienic, dietetic, cutaneous, and medicinal error is accumulated, should rally and recover their digestive powers under so wholesome and salutary a discipline?

By adhering strictly to the dietetic rules laid down in the preceding pages—which have for their object to afford nutritive materials to the economy with as little labour to the digestive organs as possible—by treating, at the same time, any local or general disease, and by attending to hygiene, we may expect to see the digestion gradually improved, even in a confirmed dyspeptic. The urine first ceases to contain uric acid, double urates, and other morbid salts, except after the digestion of food. We can then carry out the experimental essays, as to individual digestive peculiarities, which I have described at length. By so doing we attain a knowledge of the patient we are treating, which enables us to lay down the code of dietetic rules which are calculated, in his individual case, first to recover and then to retain digestive and nutritive health. It is of but little use merely to restore a dyspeptic patient to health, unless we teach him to "know himself," and to appreciate the peculiarities of his own organization, and unless we give him a guide which he may safely follow to avert the ills from which he has recovered.

This guide exists, as we have seen, for most dyspeptics, in the simple ocular inspection of their urine a few hours after taking food. If it becomes turbid, the thermometer being between 40° and 60°, they may be certain that they have not perfectly digested the previous meal, that there is "something wrong"—that there is a cloud on

the horizon. Either they are getting out of health, and the digestive functions are depraved, or there has been too much exertion of mind or body, or the meal has been an error as to quantity, quality, or time. In the first case the alarm should be taken, and the health attended to; in the second, the error should be ascertained and avoided.

The defective state of nutrition which is indicated by the presence of lithates and other morbid salts in the urine is, no doubt, a fruitful and all-important cause of disease, both general and local. On the one hand, tissue formed of chyle so imperfectly elaborated that a considerable portion of it has to be eliminated from the blood as a poison, by the kidneys, liver, and skin, cannot be endowed with the same vitality and power of resisting morbific agencies that they would have enjoyed had the chyle been perfectly healthy; on the other hand, the blood itself is contaminated until the emunctories have done their work, and purified it. We have an illustration of these facts in the prostration of body and mind, in the headache, parched mouth, and debility which follow a debauch of food, as well as one of stimulating beverages. When this is the case, the stomach has succumbed, owing to the over-work thrown upon it, and imperfect digestion, with lithatic urine, has ensued. Many diseases, both constitutional and local, which are only studied by the medical practitioner under whose eye they fall as morbid entities, are, no doubt, preceded and

occasioned by years of defective nutrition. This condition has passed unnoticed and untreated, notwithstanding the presence of lithatic urine as the ordinary condition.

The kidneys and the liver, however, are more especially exposed to danger; they are, as we have seen, the principal emunctories through which defective chyle is eliminated from the blood, and consequently they are the organs the most likely to suffer. The human filters become choked, diseased.

Irritability, amounting sometimes to sub-acute inflammation of the kidneys, ureter, bladder, and urethra, is constantly met with as the result of the presence in the urine of morbid salts. Indeed, I am never without cases of this kind under my care. What proves that the lithatic and other morbid formations are the cause of the irritability of the urinary organs is, that the latter is generally incurable as long as the urine contains them, whereas it gradually subsides, in most instances even without treatment, as soon as the urine is cleared of their presence. The more serious and fatal forms of kidney disease, as I have stated, no doubt often originate in irritation thus induced. The kidneys may excrete these morbid products from the blood for years, with little or no evil result to their own structure, but at last disease sets in. In some instances, also, urinary calculi form, the chemical nature of which varies of course according to that of the salt contained in the urine.

They are precipitated in the calices of the kidneys or in the bladder, the urine being unable to retain their elements in solution, owing to over-saturation or other causes, and constitute stone in the kidneys or in the bladder.

Derangement in the functions of the liver, congestion, bilious headache, and diarrhœa, indeed, all the common forms of biliary derangement, I constantly find to be the mere result of defective digestion and nutrition, as evidenced by urinary deposits. The proof is, that they generally subside when the digestive system is restored to a healthy state and the urine becomes clear, and that this result may be obtained without any treatment specially directed to the liver. I am constantly called upon to treat dyspeptic patients with disordered liver, who have, over and over again, gone through the routine liver treatment of blue pill and purgatives, with only temporary benefit. This occurs more especially in summer and autumn, when much more food is usually consumed than the economy requires. On minute inquiry, I find that the key to their liver symptoms is, in reality, a disordered state of digestion and nutrition, and that the biliary disturbance is secondary and not primary. In other words, I find that the liver is suffering from having to purify the blood of the carbonaceous element of imperfectly-elaborated chyle, and not from idiopathic disease.

When such is the case, mercurials and purgatives

only temporarily relieve the congested and irritable state of the organ, which soon returns under the influence of a continuance of the nutritive derangement. By removing the latter, by restoring the digestive and nutritive functions to a healthy state, the incubus of emunctory duties is taken off the liver, and in our climate it often returns to a normal healthy state without any special treatment being directed to it. Moreover, when the subsidence of biliary derangement takes place in such cases, that is, from the removal of its cause, the improvement is often permanent. The liver, ceasing to be called upon to perform emunctory duties, which irritate and disorder it, returns to its normal state, and quietly carries on its customary physiological functions.

The medicinal treatment of defective digestion and nutrition in confirmed dyspepsia is, of course, subordinate to the pathological conditions co-existing, which it is foreign to my purpose even to enumerate. Suffice it to say, that when defective nutrition is merely the result of the sympathetic reaction on the digestive system of disease existing in regions and organs other than the digestive, the principal medicinal treatment to be pursued is that of the concomitant malady. When that is removed, the digestive and nutritive power generally rallies without special treatment. If the defective digestion and nutrition is the result of actual disease of the digestive organs, the medicinal treatment must, of course, be mainly directed to subdue such disease.

The rules for such treatment will be found in the works which treat of these diseases.

In a large number, however, of the cases of morbid digestion and nutrition that are met with in practice, there is no actual disease of the digestive organs present, at least in the early stage of their existence. The functions of digestion are merely depraved, imperfectly carried on, owing to the perturbing influence of past disease, or to hygienic or dietetic errors. It is to this state that the term *dyspepsia* is commonly and correctly applied, for the digestion is, in reality, difficult, and we may add imperfect. Dyspepsia may exist for many years, and yet after death no lesions be found in the stomach or other organs. It may be soon followed, on the contrary, by the development of actual organic disease in one or more of the organs which participate in the digestive and nutritive processes—the stomach, intestines, lungs, kidneys, liver, etc.

In simple but confirmed dyspepsia, the hygienic and dietetic treatment already insisted on is, in my experience, of infinitely more avail than medicinal agents. Indeed, a dyspeptic patient who obeys the various hygienic and dietetic rules above insisted on, who avoids past errors, ceases to overstrain his mental faculties, and is free from corroding cares, may often dispense with their aid. It is no doubt by rigid attention to hygienic treatment that homœopathists occasionally succeed in restoring to health dyspeptic sufferers who have failed to recover under

medicinal treatment. Steady perseverance, however, for a lengthened period, often extending over months or even years, may be necessary, even in the absence of organic disease, to secure the recovery of impaired digestive and nutritive power, and eventually a return to sound health.

Medicinal agents may, however, always be resorted to with advantage as adjuvants, and sometimes they will accomplish in a few weeks what diet and hygiene alone would take as many months to effect. The medicines which are the most useful are antacids, acids, vegetable bitters, sedatives, and digestive adjutants, such as pepsin, ox-gall, and pancreatic emulsion introduced by Dr. Dobell.

In some forms of dyspepsia the gastric juice appears to be secreted in too great abundance, or its acidity is abnormally great, or anomalous acids are developed in the course of the stomachal digestion. Under such circumstances sour acid eructations are experienced. There may be great flatulence from the evolution of gases, which painfully distend the stomach, and pain may also be felt, sympathetically, in the region of the heart or stomach. When these conditions are present, the administration of antacids—soda, lithia, potash, or magnesia—often affords relief. This is so generally known to be the case, that the mineral-waters which contain them, such as soda-water, Seltzer-water, or Vichy-water, have become popular beverages, and are constantly

taken with benefit, for acidity and dyspepsia, without medical prescription. They certainly appear often to correct the stomachal acidity, and to facilitate the digestive process.

In these mineral waters the quantity of the alkalies is but small. When it is considered desirable to give the latter medicinally, they are generally given in much larger doses, and must be so given if their chemical effect on the secretions is to be produced. From ten to thirty grains of the bicarbonate or acetate of potash, of the bicarbonate of soda, or from ten to twenty minims of the liquor potassæ, taken three times in the twenty-four hours, diluted in any fluid, will generally change in a few days the chemical reaction of the urine; the latter becoming alkaline instead of acid. At the same time the formation and deposit of urate of ammonia after the digestion of food frequently diminishes or even ceases, and the general state of the patient improves; the train of dyspeptic symptoms becoming less marked.

In recent dyspepsia, not kept up by constitutional causes, or by the sympathetic reaction of other disease, or by gross errors in diet, this improvement may be permanent, continuing when the use of the alkali is suspended, and when the urine has recovered its usual acid reaction.

But in confirmed chronic cases, in which the dyspepsia is kept up by some constitutional diathesis, such as gout, or when it is connected with

other disease, such as uterine disease undiscovered and untreated, or when perpetuated by errors in diet and hygiene, the improvement is merely temporary. The clearing of the urine, in such cases, appears to be merely a chemical change, induced by the chemical action of the alkali on the blood, and not the result of the improved digestion and assimilation of food. On the one hand, the dyspeptic symptoms do not abate, and on the other, as soon as the alkali is suspended and the urine regains its acid character, the lithatic deposit reappears, sometimes with the same profusion as before, sometimes in a diminished quantity.

In many instances, even when the digestion appears to regain its normal power under the influence of alkalies—the dyspeptic symptoms abating and the urine remaining clear after the cessation of the remedy—the improvement is only temporary; notwithstanding the greatest attention to diet and hygiene, after a time the urine again becomes loaded, and all the dyspeptic symptoms reappear.

In both these conditions recourse must be had to other medicinal agents. The alkalies, when given for a considerable time, are thought to impoverish the blood and to weaken the economy; so that if their administration for a few weeks is not attended with success, or is only temporarily successful, they should be abandoned. Great benefit may frequently be derived under such circumstances from the mineral acids, nitric, hydrochloric, phosphoric, and

sulphuric acids; and from vegetable bitters, such as gentian, calumba, chiretta, and quassia. These agents may be given alone or combined. I always give the acids largely diluted in water, and tell the patient to take them as a beverage, often using a glass tube, to save the teeth from contact.

The vegetable bitters are best administered in infusion; but to obtain the full benefit which they are capable of affording, the infusions should be taken in much larger quantities than is usual. Half a pint a day, taken in two or three doses, is not too much. The acids and bitter infusions may often be combined with advantage.

Both acids and bitters act as tonics on the stomach and on the system at large, and their administration is frequently attended with considerable benefit. The effect, however, is very gradual, and they must often, therefore, be continued for some time —one, two, or three months—before the desired result can be obtained.

Sedatives, such as henbane, opium and its preparations, belladonna, prussic acid, chloroform,—antispasmodics, such as valerian, camphor, musk, myrrh, and the ethers, act principally in subduing pain, in controlling spasm and abnormal conditions of innervation. Bismuth is often a valuable therapeutical agent in larger doses than are usually given, ten, fifteen, or twenty grains, three times a day, after food.

These various medicinal agents may be combined

with advantage. Their administration, however, does not in any way absolve the medical practitioner and his patient from the necessity of attending most scrupulously to the dietetic and hygienic rules developed in the preceding pages. It is only by uniting strict attention to these rules with medicinal treatment that the latter can be made really beneficial. Without dietetic and hygienic care, no medicine, however judiciously selected, can restore to health a patient whose digestive system and nutritive powers have been seriously impaired.

Mere medicinal treatment, without attention to diet and hygiene, is not only useless but an utter absurdity. Of what possible avail can it be to give a few grains of this or that medicinal substance to dyspeptics who are daily ingurgitating pounds of food which they cannot digest and which poisons them, and pints of fiery alcoholic liquids which stupefy and impair the nervous system?

In some exceptional instances the depraved state of the digestion, and the defective nutrition which follows, persist as constitutional conditions, notwithstanding the removal of all co-existing disease, and the most rigid and scrupulous medicinal, dietetic, and hygienic treatment, continued for months or even years. In some of these cases there may be obscure structural disease of the stomach, of the liver, or of other organs connected with digestion, which it is foreign to my purpose here to investigate. With others, these conditions are evidently the

mere result of a confirmed morbid habit, of some constitutional state, such as the gouty diathesis transmitted by heredity, of some unfavourable hygienic condition, or of mental anxiety and distress. This latter cause is a fruitful source of confirmed dyspepsia, with all its concomitant evils; and as long as grief and sorrow exercise their depressing influence all efforts to control the dyspeptic state of the patient may utterly fail. Indeed it is by depraving and disordering the digestive and nutritive functions, and by modifying innervation, as we have seen, that grief kills; not by "breaking the heart," as is popularly supposed.

The gouty diathesis, when it is the result of hereditary taint, has proved in my experience the cause of some of the most intractable forms of dyspepsia, both in male and female, that I have met with. Indeed, I believe that dyspepsia, recognizing this cause, is in some instances quite incurable, and can only be palliated. It is a sad legacy that the gouty, from self-indulgence, often leave to their children, even when they themselves are free from it. Singularly enough, it does not show itself, necessarily, in all the children of a gouty father or mother, but only in one or more of the number. The children of gouty parents ought more especially to follow the hygienic and dietetic laws laid down in these pages, if they wish to escape much suffering. As a rule, they ought to be all but water-drinkers throughout life; they have to pay

the penalty of the progenitors' excess or dietetic errors. If the gouty diathesis is strongly marked, they should be most moderate and abstemious in their food habits, and lead as active and muscular a life as possible. Indeed, they should never lose sight of the fact, that a miserable, gouty old age may be their fate, should their life be prolonged, unless they make many sacrifices to ward off the impending danger.

In such cases as those we have been describing, in which dyspepsia, or defective digestion and nutrition, persists, notwithstanding the most judicious and careful treatment, the urine remaining turbid and loaded with morbid salts after digestion, the patient must not despair. It would be folly to give up all efforts to recover health, as many feel inclined to do. On the contrary, the sufferer should follow out more scrupulously than ever dietetic and hygienic rules, and that *indefinitely*, in the hope that sooner or later the digestive functions may thereby be restored to a healthy state, or that the dyspeptic condition may, at least, be limited and controlled.

In life health, as in social life, men and women often appear to pass through phases of suffering, of varied disease. They are and may be, as the saying is, "under a cloud" for years, apparently breaking up; but their vitality gradually gets the better of these aches and pains, suffering subsides, health improves, and they emerge at twenty, forty,

or even sixty, into a state of health, of freedom from invalidism previously unknown. It is to such cases that the term "taking a new lease of life" is applied by popular observation.

The rules to be followed may be recapitulated in a few words. The dyspeptic should give up late hours and the dissipations of society, and if possible live in the country. If not possible, if he is a denizen of towns, he should endeavour to reside out of their immediate influence, in the parts the least densely inhabited, or in the suburbs. Regular exercise, walking or riding, should be taken, and the amount should be gradually but cautiously increased; great care being observed not to overtax the strength. From eight to ten hours' sleep or rest in bed should always be allowed; the hours for retiring and for rising being invariably the same. The hours for meals should also be established, and adhered to with the strictest regularity. All, or nearly all, fermented and alcoholic beverages should be discarded, water being taken instead; and stimulating non-fermented beverages, such as tea and coffee, should be taken, very weak and in moderation. There should not be more than three meals daily, and one only of the three should be a solid one; that is, consist of flesh, fowl, or fish. The intervals between these meals should be at least four hours; and no food, solid or fluid, should be taken between meal hours, or within two or three hours of retiring to rest. No spices or seasonings, no uncooked

vegetables, should enter into the dietary. It should be varied, and consist of the very lightest kind of nutritious food, vegetable and animal, such as bread, potatoes, milk, eggs, butter, fish, fowl, game, and meat, and more of the former than of the latter. Such a dietary, be it remembered, is not a low, but merely a *light* dietary.

Lastly, the quantity of the food should be rather less than what is usually ingested in health. Should loss of weight occur, the food amount must be gradually increased until the loss ceases. No preconceived dietetic scale as to the amount of food required will take the place of periodical weighing; the food requirements, or power of extracting from food nutritive elements and of assimilating them, varying, as has been repeatedly stated, within very extreme limits. We must not forget that many will thrive and do well on an amount of food which would be quite insufficient to others, inasmuch as it would not in any respect satisfy the wants of their economy. Attention to individual peculiarities, pertaining to the hours and frequency of meals, and to their nature, is more especially necessary in the case of the confirmed dyspeptic.

When digestion is inefficient, and the economy is positively poisoned by imperfectly-elaborated chyle, among the symptoms usually observed constipation occupies a very prominent position. It is generally treated by aperient medicines, often combined with blue pill or mercury, owing to the co-existence of

congestion and of disturbance of the functions of the liver.

Purgatives really relieve, but for a time only; and their habitual use increases the mischief, especially when they are combined with mercurials. The liver and intestines, accustomed to be stimulated by medicinal agents, become more and more physiologically torpid, functionally inactive, and only act, at last, when medicinally coerced. These perpetual alternations between inaction and over-action contribute to aggravate the digestive inefficiency.

In such cases the constipation ought to be considered as merely the result of a defective state of digestion, and of the elaboration of unhealthy bile, which does not physiologically stimulate the intestines to action. The real and permanent remedy is not blue pill, calomel, and purgatives, but the restoration, principally through hygienic and dietetic means, of the digestive and nutritive functions. When they really are restored to a healthy state, the urine becomes clear and free from morbid salts, and the liver secretes healthy bile, which, generally speaking, stimulates the bowels to healthy and spontaneous action.

Until this result is attained the physician and his patient should not weakly succumb to the constipation, meeting it by purgatives, but battle with it. First, dietetic and hygienic means should be tried; brown bread, or oatmeal porridge, ripe fruit in summer, — stewed fruit, pears, apples, prunes,

figs, in winter,—the shower bath, or cold sponging in the morning, a glass of cold water on rising, a dessert or tablespoonful of sweet olive oil night and morning, or half an hour's walk before breakfast. These various agencies, combined or singly, will often turn the scales, and produce a regular action of the bowels without having recourse to medicine. Should they fail, about half a pint of cold water, at summer heat, say from 60° to 70°, should be slowly injected into the bowel, half an hour after breakfast, and retained from five to ten minutes; indeed, that quantity of water only should be injected which the patient can retain with comfort. If the water returns alone, it is generally a proof that the want of action is not in the lower bowel, and when such is the case, the temporary inaction is not of so much importance in a health point of view; we can therefore better afford to wait for Nature unaided to act.

Should, however, the cold enema fail two mornings successively, it becomes imperative to come to the assistance of the inactive upper bowel, and an aperient should be taken. The aperient should be of the mildest kind, the object not being to purge the patient, but merely to obtain on the third morning one natural but satisfactory motion. There are few cases—even of constitutional constipation—that are not much improved, if not entirely remedied, by a steady perseverance in this plan of conduct, at least in early and in middle life. With the aged,

constipation is often merely a phase of the increasing torpor of organic life, and, as such, is incurable. When this is the case, purgatives become indispensable. To the habitual dyspeptic, on the contrary, it is all but a condition of recovery that he should be freed from the necessity of daily taking purgative medicine. This fact ought to be more generally appreciated than it is, both by the profession and by the public.

There are some other facts connected with the history of habitual constipation which deserve notice. When the alvine evacuations are confined, they are generally small in volume. The fæces lose their soft, moist character, from the gradual absorption of the fluid element in the large intestine, where they principally lodge; the result being a hard compact motion, occupying very little space. The alvine evacuations, even in health, it will be remembered, only weigh a few ounces in a healthy adult rationally fed. Thence, in the mind of the patient, the often erroneous impression that there must be a lodgment somewhere, and a continually renewed attempt to increase the volume of the fæces by purgative medicine. As long as the motions which take place, under the influence of medicine, are loose or semi-loose, they are voluminous, and thereby satisfy the preconceived notions of the patient; but as soon as they again become constipated and small in volume, he reverts to his former impressions. Under the influence of these

ideas, purgatives are taken or given, often to a very pernicious extent.

It is not only in confirmed constipation that erroneous views are frequently entertained as to the healthy amount of the alvine evacuations. Many physicians appear to think that the more abundant they are, the more satisfactory and the more conducive to health is their own state or that of their patients. This is a very great error; the fæces, as we have seen, ought only to contain the indigestible residue of food, with a little bile, and a few salts. When they are very abundant or voluminous, it is generally owing to more food having been taken than the stomach and digestive organs can chymify; such being the case, the surplus escapes partly digested, or even unchanged, through the bowels, after overburdening and disturbing the entire intestinal canal.

Many a hypochondriac half destroys himself by purgatives, under the influence of this egregious mistake. Many a doting mother, imbued with this fatal error, does her best utterly to destroy the digestive system of her children; on the one hand by overfeeding them, and on the other by drenching them with purgatives, in order to obtain the voluminous motions which, in her blind ignorance, she deems necessary for their health.

CHAPTER IX.

RECAPITULATION—VITAL FORCE.

In concluding this survey of the functions of digestion and nutrition in health and disease, it may be desirable briefly to recapitulate the leading facts and opinions conveyed in the course of the work.

I have endeavoured to show that defective digestion and nutrition—often unrecognized and untreated—is the cause of a vast amount of functional and structural disease, more especially in the chief emunctory organs—the kidneys and the liver; and that it prepares the way for many morbid conditions, usually studied as entities or individualities, and considered only with reference to the causes which have "more immediately" produced them.

I have also attempted to show that, apart and in addition to the general symptoms of defective digestion generally studied and recognized, the examination of the urine—physical, microscopical, and chemical—generally affords the most delicate and surest test of the condition of the digestive and

nutritive functions. If the latter are defective, a few hours after the ingestion of food the urine is generally found to contain morbid salts, and to become turbid on cooling.

The presence of these morbid salts, under such circumstances, is a proof of the imperfect digestion of food; imperfect nutrition following as a necessary consequence. Their existence, therefore, implies danger to the organization; and a danger not the less real that it may be more or less remote. This clinical fact affords the physician the safest and most tangible guide in the dietetic, hygienic, and medicinal treatment of his patient. The patient also, when aware of the meaning and importance of urinary deposits, finds in the turbidity which they usually occasion in the cooled urine an easily recognized guide in the management of his diet, and in that of the daily routine of his life.

Many, very many, are ever unconsciously floating into disease, suffering, and death, through the silent operation of defective nutrition. And yet the morbid nutritive changes which, as we have seen, so often *precede* disease, might generally be arrested, were the unconscious sufferer aware of the danger that accompanies and follows their existence.

Defective nutrition, in the early stages of life, in the nursery, unrecognized by those who have the management of children, is the probable explanation of one of the problems of practice. Healthy parents, still young, constitutionally well endowed,

living under favourable social circumstances, not unfrequently have children who, although apparently healthy at first, sicken and die of phthisis and of other diseases as they grow up. During the latter years of my practice, at Mentone, a sanitarium on the shores of the Mediterranean, I have every winter witnessed such cases. I have seen healthy mothers and fathers deprived, one by one, of their children by phthisis, without any tangible cause. I am convinced that the real cause must often be sought for in erroneous nursery management, in defective nutrition early in life.

The analysis of the functions of life contained in the preceding pages would be incomplete were I to omit once more emphatically to recognize the mysterious vital influence which controls all organic manifestations.

It is this vital principle, transmitted from one animated being to another, that accounts for the singular fact that with pretty nearly the same physical organization one animal lives and thrives on grains, another on grasses, a third on flesh, a fourth on all three. Although the fact may be accounted for by "inherent vitality," it is not thereby explained. All our knowledge, chemical, anatomical, and physiological, fails to penetrate this great mystery.

The mighty Author of all things has endowed all animated nature with an inherent power to live and to reproduce the parent organization; but the

reason and the variations of this vital power can only be found in His will. To our finite comprehension its nature is totally incomprehensible, and its manifestations are only very partially reducible to rule. This inherent vitality is not only different in each species of animals or plants, but also in each member of the same species. We may, through the application of the laws developed by science and by experience, estimate its strength in individual cases, but only within very narrow limits.

The Greeks and Romans of old were close observers, and in their heathen mythology we find a knowledge of human nature and of life as profound as that of any observer of modern times. Thus the fable of "the Fates" is founded on the recognition of variable inherent vitality at the birth of every human being. They spun a web of gold, of silver, of brass, and these webs were long, medium, or short; and so it really is. The inherent vitality of the human being may be utterly exhausted at one, five, ten, or twenty.

In health, as in life, "the battle is not *always* to the strong, nor the race to the swift." Some whose family antecedents are good as regards constitution and health, and who have always appeared strong and hardy, in the hour of trial show no real vital strength, and at once succumb, if exposed to hardships, or if attacked with disease. Others, on the contrary, who can boast neither of

good family antecedents nor of personal health, live on through every untoward ordeal, physical and mental, and eventually attain old age. With them the "grasp upon life" is so strong, so tenacious, that they victoriously resist every influence, however unfavourable. As children, they may be neglected and badly fed; as men, they may be exposed to fatigue, to mental distress, to malaria and to disease in every shape; and yet through their strong inherent vital power, they resist every morbid influence, or, succumbing for a time, eventually rally and regain their footing on the shores of life.

Belonging to this class are—the habitual drunkard, who yet attains old age; those who pass through threescore and ten years of disease and physical suffering; those who live long years in malarious, death-giving districts; the soldier who, if he escapes the enemy's ball, passes scathlessly through twenty campaigns; and the barrister who reaches the woolsack after half a century of mental toil and bodily inaction.

In all, the vital principle must have been exceptionally powerful, the hold upon life must have been exceptionally great, from the moment they drew their first breath. They are exceptions to the general rules which regulate health and life, and the exception has its explanation in this very intensity of the vital power which we recognize in its results, but can neither comprehend nor always foresee.

That such exceptions should occur is one of the most bountiful dispensations of Providence. Thus is the hope of long life given to all, even to the weak and the sickly. No human science or skill can unerringly estimate the inherent vital power of a fellow-being, however stricken by illness. If no organ indispensable to life is irretrievably compromised, the vitality of the sufferer may yet enable him to rally, to shake off disease, and to live to the allotted age of man.

FINIS.

APPENDIX I.

Mineral Aliments in Plants—The Influence of Heat in Accelerating Vegetation.

In the present work I have only devoted a few pages to the nutrition of plants, merely wishing to explain the chemical basis on which the nutrition of the animal world is based. To enter fully into the subject of plant nutrition would have taken a volume.

One of the most interesting features of modern research respecting the nutrition of plants is the discovery of the important part performed by mineral aliments. The old doctrine that decomposing vegetable substances, and the humus which is the result, were the all-important fertilizers of the soil, and, in a great measure, the origin of the carbon of plants, has been dethroned. Mineral aliments—represented by the nitrates resulting principally from the decomposition of animal substances, by the break-up and decay of rocks, in agriculture by guano and artificial manures, and by the oxygen and ammonia of the atmosphere—have been considered by many authors all but the sole origin of plant food, as stated at page 85. But these views are probably too one-sided, and the truth may, as is usually the case, be between the two theories.

Such is the view taken by Dr. Maxwell Masters in his recent edition of "Henfrey's Botany," a most valuable and interesting work. He therein states (p. 560) "it has been common in recent works to find the value of humous or carbonaceous matters in the soil estimated very low; they

have been regarded either as merely improving the (physically) absorbent power of soils, or as sources of carbonic acid, already sufficiently provided by the atmosphere. But the above observations (Mulder's researches), borne out by the experiments in turnip growing by Lawes and Gilbert, are in favour of a higher estimate of the value of decaying carbonaceous matters, and of regarding them as important constituents of farm-yard manures for certain purposes. Lawes and Gilbert found that stimulating nitrogenous manures in excess were rather detrimental to the growth of turnips, leaf formation going on at the expense of the roots; but this was counteracted in a great measure by supplying, with the nitrogenous manures, carbonaceous substances in considerable proportion."

It is a remarkable fact that many plants, like animals, have preferences as to the kinds of food they like; they have constitutions which require certain kinds of (mineral) food, and by which they are distinguished from other plants. Thus there are lime-loving plants which only thrive on lime soils, sea-side plants which only thrive in an atmosphere or soil containing sea salt (chlorine). Again, there are plants which only thrive in soils in which these two mineral elements are absent, or all but absent, such as those that principally occupy sandy soils at some distance from the sea.

The following remarks on the subject of mineral aliments in plants, and on the influence of heat in accelerating vegetation, were published in the *Gardener's Chronicle*, of August 21, 1875. I reproduce them here as bearing forcibly on this interesting subject.

In your issue of last Saturday (August 14) there are two questions raised, respecting which my experience of the Mediterranean shores and islands enables me to contribute a little information. 1st. The power of mineral *detritus*, or dust, to support vegetation, not only that of vines, but of cereals and of fruit trees, alluvial soil or humus being all but

absent. 2nd. The comparative influence of temperature in leaf development in southern and northern climates.

The entire north shore of the Mediterranean, from Gibraltar to the Dardanelles, with the exception of the mouths of rivers, may be said to be a mass of rocky mountains, principally calcareous, sometimes schistic. The southern flanks of these mountains or rocks are generally more or less precipitous, and burnt as they are by a southern sun, with a five or six months' summer drought, present but a scanty vegetation, pretty nearly everywhere of the same character—Borage, Thyme, Juniper, Euphorbia, Taraxacum, Cistus, Lavender, Rosemary, Mediterranean Heath, Lentiscus, Maritime Pine, Aleppo Pine, etc.; and, where cultivated, Olive, Orange, Lemon, Almond, Apricot, Peach, Vine, Opuntia, etc.

The wild plants and trees above-named cover the rocks sparsely, so as often to be scarcely perceptible at a distance, but grow healthily, if not vigorously. If their roots are traced they will generally be found to have entered a crevice, or fault in the rock. In calcareous rocks these crevices are very common on the surface. If such rocks are broken or blasted they will generally be found to present them in great numbers, and the roots of the plants growing on the surface will be found therein contained; often, but not always, surrounded by a little vegetable soil, the result of the decay of similar roots, their predecessors for countless ages. These plants and trees subsist clearly, in a great measure, on atmospheric and mineral food; for they get scarcely any other.

The cultivated plants and trees being all grown for the fruit they produce, although in a congenial climate, require man's assistance to produce it of good quality, and this is the way in which such assistance is given. Terraces or shelves are formed by the pickaxe, hammer, or by blasting, on the side of the mountain. These terraces are filled with broken and powdered stones. A little road-dust or a little vegetable soil, if it can be found, is scattered on the stones; a hole is

made therein, a handful of manure is placed at the bottom, and the fruit tree planted. Under these conditions, it thrives and produces fruit, if watered during the season of drought. Surely, under such conditions, the plant-food must be principally the carbon of the atmosphere and the mineral constituents of the rocks.

Just under my rock garden at Mentone, which is 300 feet above the sea, and itself formed of successive terraces or shelves, as described, this process has been going on for the last four years, and I have been observing it with great curiosity and interest. A jetty or pier is being made, and the contractor in search of stone bought the terraces below me, which were covered with healthy Lemon trees, in full bearing, some twenty feet high, with trunks a foot in diameter. These terraces have been one by one consumed to make stones, *pour faire des pierres*, as the local saying is, the trees being cut down, and the earth scattered. This has given me a splendid opportunity of observing and studying in succession the entire thickness of the terraces in which these healthy Lemon trees were growing.

To my surprise, I found that there were only eight or ten inches of red calcareous soil on each terrace, then eighteen inches of small calcareous rubble, and then the rock. The trees had all rooted well into the rubble, but never penetrated more than two feet from the surface. Thus perched up, as it were, on shelves, on a dry and all but precipitous rock, in the full blaze of a south-west Mediterranean sunshine, growing in only eight inches of poor rocky soil, they formed a luxuriant grove or wood, producing fruit in abundance. The only assistance they wanted or got was water once a fortnight in summer, and a little manure, in a trench, three feet from the trunk, every two or three years, principally composed of old rags, a nitrogenous manure, very commonly used on the Mediterranean shores.

The destruction of these terraces enabled me to witness and study the formation of others. One of my neighbours

still lower down, owned a rock immediately overlooking the sea, to which it descended by a rapid slope like that of a house-top. Seeing valuable soil wasted in the quarrying above described, he determined to buy it from the contractor and to utilize his naked rock. He first made a large reservoir, capable of holding 10,000 cubic feet of water, and then commenced quarrying his terraces on the rock, for it amounted to that. With the larger blocks of stone he built up the outer wall of each terrace some ten feet wide, the next-sized stones were put at the bottom, the small ones above, and on the top were strewn four or five inches of road sweepings and of the bought soil; then some young Lemon trees, five years old, were planted as described, at about ten feet distance. They now form pretty young fruit-bearing Lemon trees. The bare rock has truly been transformed into a garden.

At Malta I saw, in May, 1874, identically the same process going on, but on less precipitous rocks. The formation of Malta is also calcareous, and the wild vegetation is, in a great measure, that of these rocks in the entire Mediterranean basin. A great part of the island is under cultivation, but in some parts the bare calcareous rock crops out to the surface, like the bones of a half-starved man coming through his skin. Here and there it is in process of redemption, and a marvellous process it would seem to a Yorkshire farmer. The pickaxe, hammer, and blasting powder are brought into requisition, all protuberances are levelled to the ground, walls are built with the larger blocks, the small stones and stone-dust are spread over the enclosure; then road sweepings, soil, manure, anything that can be got, is strewn over the field, and cultivation at once begins. Beans, peas, cereals, and cotton are planted, and, wonderful to relate, they flourish and produce crops—heat, light, sunshine, and water, aiding, and making them all but independent of a rich loam soil.

Olive trees, and all kinds of fruit trees, will flourish and live in these rock-dust terraces, and with the addition of a little manure and water will produce good fruit abundantly.

It really would seem as if in this climate, with its mild temperature in winter, its heat in summer, and its intense light, mineral and atmospheric aliment were all but sufficient for mere plant nourishment. This fact is admirably illustrated by the Carouba tree. It is a splendid evergreen tree, abundant in Syria, in Palestine, indeed, in the driest regions of the Mediterranean shores, which grows as large as a good English oak, and is as well supplied with foliage. This tree flourishes in the rockiest, driest situations, on the slope of precipitous, sun-burnt, calcareous rocks, where there is no vegetable soil whatever, except what is contained in the crevices and cracks of the rock.

I would remark that most of the plants and trees, that seem in the south all but independent of soil, that appear to be able to get their mineral constituents (only a few per cent.) out of the rocks, and their carbon out of the atmosphere, are evergreens, which feed atmospherically all the year round, as is the handsome Carouba. A remarkable exception, however, is the Terebinthus Chio—the last shrub or tree which shows itself in the Desert of Sahara, acccording to Dr. Tristam. It grows freely and luxuriantly on my rocks, as well as at Chios, and in the Great Desert, but is leafless from December to April, to my great annoyance.

The remarks in your leader on "Heat" (p. 204) have brought vividly to my mind a fact connected with the progress of vegetation in the Mediterranean in the spring, which I have never been able satisfactorily to explain, viz., Why is the leaf development of deciduous trees so tardy in spring in a climate so much milder, so much warmer than that of the North of Europe? Taking Mentone as the centre of observation, there is at least two months' difference in the flowering epoch of surface flowers and of small shrubs, such as Roses, when compared with the North of France, or the South of England; whereas the difference is not more than about three weeks or a month when we study deciduous

trees, Willows, Poplars, Planes, Oaks, etc. According to my own observations, based on 15 years, the average minimum for February is 43·9°, the maximum 55·7°. The minimum of March 45·3°, the maximum 59·3°; the minimum of April 50·8, the maximum 66·3°. With such temperatures, aided by abundant spring rains in March, one would have thought that the deciduous trees would have been in full leaf by the end of March, but it is not so, they are not in full leaf until the end of April—scarcely then. I may mention a remarkable illustration of this fact. On May 6, 1874, I was at Tunis, on the south shore of the Mediterranean, in the latitude 36° 48′ N., and went to visit the Bardo, the Bey's palace, which is some ten miles away from the sea; Tunis itself being six. Outside the palace there was a grove of large healthy Walnut trees, which had not a single leaf! The leaf-buds were large, swelling, but not one had expanded.

I thought at one time, and, to a certain extent, think so still, that the difference between the development of the surface flower vegetation and that of the trees, was owing to the ground at the surface becoming early in the season thoroughly warmed by the sun's rays, which did not penetrate deeper, to the roots of the deciduous trees. But I kept a thermometer for several winters, at two feet below the surface in my garden, and never found it under 45°; so with roots at 45°, and the trunk and branches in the temperatures given, we might expect earlier leaf development in spring.

May not light, and the comparative duration of daylight, have something to do with the question? As we advance north the days become much longer than they are in the south, and the nights shorter. This, no doubt, has a deal to do with the ripening of crops and fruits in northern regions. Even in our own island crops and fruit are ripening this year under an unusually low temperature. At the end of last month (July), and at the beginning of this, the thermometer repeatedly went down nearly to freezing point. Indeed, we have had during the last month of midsummer the

thermometer oftener below 40° than at Mentone during the six months of winter, and yet all summer fruits are ripening, each after its kind.

Then we must not forget the habit, the nature of plants, which it is difficult to modify. My gardening experience at Mentone gives me many illustrations of this fact, one of the most remarkable of which is the history of the snowdrop. I take out a number every year for "auld lang syne," and plant them out in October, but they never flower sooner than February, wherever I may place them, in the blaze of the sun or out of it. They will not be put out of their way, and flower with me just at the same epoch as they would in the snow in the Shetland Isles. I would add that snowdrops that have remained in the ground for years, and have borne the tropical heat of the summer, do not flower sooner than those just imported from England. They are equally true to their "nature."

I can, however, get two months' advance with most garden flowers, but I cannot get three. I can get in March our garden flowers of May, in April those of June, but by no treatment can I get in March and April the flowers of July and August, although were it a question of heat alone, there is quite enough to develop them at an earlier period. This is so much the case that, as I leave in the month of April, I have all but concluded to make no further attempt to flower in the open air any plant that does not bloom until July in the north of Europe.

APPENDIX II.

Why do Successful Medical Men often Die Prematurely?

Æsop's Fables of old always concluded with a moral; so, following this time-honoured example, I append as a moral to the preceding work a short essay which I published in June, 1870, in the *Lancet*. It was written under the influence of a feeling of sadness produced by the early death of several eminent professional friends, whose absence from our ranks I still mourn, and it illustrates, I trust vividly, some of the nutritive dangers to which are exposed the members of our profession.

It is admitted by all statisticians that medical men are a short-lived race—indeed, that the standard of mortality in their case is that of unhealthy trades. Why should it be so? As a rule, medical men are well-fed, well-housed, well-clothed members of the community; and the occasional risk incurred in ministering to contagious diseases scarcely accounts for the shortness of their lives, for their premature age, sickness, and death.

Such thoughts have often crossed my mind of late years. When a man has passed his fiftieth year, his contemporaries and companions begin to drop off around him in great numbers, in every class of life; but in our profession the mortality is evidently greater than in other professions. This mortality is also evidently greatest among its most intelligent and most eminent members—a fact which appears to me to contain

within itself the key to the question I have put. May it not be that such men succumb and disappear from our ranks *because* they have been great workers, and consequently successful in their generation?

If it is so, if the most valuable lives in our profession are constantly being brought to a premature close through the overstraining of vital powers which success brings, would it not be well if the positive danger to life of great success were more generally enforced and recognized? Our lectures and class-books teem with warnings respecting the dangers of sloth, of inactivity, of mental stagnation. May not a few words of warning be added on the dangers of work and success? If so, they will not come inappropriately from one who failed physically, years ago, through overstraining of mind and body—from one whose recovery has been principally due to his having seen the error of his ways before it was too late, and to his having accepted and followed the laws of physiology and hygiene, formerly ignored, as they are nearly always ignored by the whole tribe of mind and body workers.

The particular feature of the medical profession is, on the one hand, that work increases with age, and, on the other, that the public do not consent to look upon aging medical men as veterans, but exact from them, to the end, the labour of youth. In all other professions, as age advances, and renown and prosperity increase, assistance, relief, come naturally. The barrister has his junior counsel who prepares his briefs, the solicitor his head clerks, the vicar his curates, the colonel his staff of officers, the merchant or banker his junior partners; but the successful consulting physician or surgeon must stand alone, whatever his age, and do his work entirely himself as long as he practises. Thus, *after* the age of forty or fifty, the hours of positive work increase rapidly, instead of diminishing.

An officer of fifty or sixty, after thirty or forty years' service, is considered to have gained a claim to repose for the rest of his days. Even a missionary, after less than thirty

years' labour in the cause of religion, is pensioned off, and thought to be entitled to honourable rest for the remainder of his life. But a medical man of fifty or sixty, after thirty or forty years' labour in the cause of health and life, is still called upon by public opinion to work like a young man. If he does not rush night and day, not only to assuage real disease, but at the voice of vain fears and caprice, if he transfers night-work and gratuitous or ill-paid attendance into the hands of his juniors, he is considered hard-hearted, mercenary, devoid of Christian and Samaritan feeling. In a word, public opinion makes it difficult for him to withdraw into the Areopagus of science, to become a deliberative and not a militant member of the profession. Nor is the public altogether to be blamed, because it is only by raising his fees that the medical practitioner can erect the barrier which is to defend him from the burden of work he is no longer able to bear. Thus, to many of the thoughtless it appears as if he only wished to get larger remuneration for his services, although his real wish is merely to eliminate, to keep at bay, some of those who would wish to employ him. The only means at his disposal to diminish work brings upon him an odium he too often has not the courage to incur. So he works on, old and feeble, responding to every call, until at last death prematurely closes the scene.

Between forty and fifty a man of average constitution is quite equal to success and to the hard labour that it entails in any branch of the profession, to work by day and by night, to care and responsibility, although the weak ones succumb, as did Todd, Brinton, and many others I could name. But when fifty is reached and passed, the human economy begins to decline. The hair becomes grey, the sight fails, the gums abandon the teeth, adeps is deposited in unwelcome regions, and many other signs of nutritive deterioration show themselves. No doubt nutritive power is diminished in the entire economy, and the tendency to morbid nutritive conditions steadily increases.

This is just the time when the labours of the successful practitioner increase to the greatest possible extent: and as the brain is the last to give way in the intellectual man, he works on under mental and nervous pressure. By sixty or thereabouts the climax is often reached. The overstrained organization ceases to respond to the mental stimulus, and death ensues through some form of nutritive aberration, which has been slowly but surely progressing. Such was the case with our recently-mourned brethren, Simpson and Nunneley, the one fifty-eight, the other sixty-one.

Can this sad expenditure of life amongst the worthiest of our profession be arrested, be avoided? I think myself that it might, if we could cease to live as if we were immortal, as if the diseases we saw daily did not pertain to us; if we would listen to the teachings of physiology, and discard the miserable vanity of thinking that we are exceptions to the general rule, and that at fifty or sixty we are as young and strong as we were at thirty or forty. To accept this lesson however, we must analyze ourselves, and, if we find ourselves wanting in vital power, thrust aside the scarlet cloak of nerve stimulants—alcohol, coffee, tea, by means of which, I believe, it is that efforts inconsistent with real vital and nutritive power are made by workers in general, and by medical men amongst the number.

A man who meets age, or debility, or want of constitutional power by alcoholic stimulants, even in moderation, by coffee and tea, conceals his real nutritive condition from himself. When both the nervous and muscular systems are exhausted and want repairing by legitimate nutrition—by beef and mutton, bread and rest, a man may galvanize his economy by nerve stimulants so as to be equal to nearly anything up to the last. But the process is a destructive one, exhausts vital power, impairs healthy nutrition, and lays the foundation for morbid organic changes.

By alcoholic stimulants constantly repeated whenever exhaustion supervenes, the power of work may be kept up

until within a few days or hours of death, as we constantly see in the lower classes of life. Tea and coffee have nearly as great an apparent nerve-stimulating, strength-supporting power. Let any one who doubts it take a cup of strong tea or coffee when exhausted from want of food and from physical fatigue. The craving for nutritive elements to repair waste, and the sense of fatigue, both disappear in ten minutes, and a couple of hours' more abstinence and work are easily borne. But what have we done? The physical organization wanted repair, wanted the elements of nutrition, the nervous system rest, and we do worse than give them a stone, for we flog them, we galvanize them, into continued action.

Night work is principally done on such stimulation. The student, the writer, young or old, who retires to his study in the evening to work, does so on tea or coffee. The tired brain wants sleep, it is galvanized into intellectual labour. Is it surprising that morbid organic conditions should occur in the long run? For we must recollect that the nervous system rules over all organic and nutritive changes, normal and abnormal.

Every June a *conversazione* takes place at the College of Physicians, which is attended by most of the medical and surgical celebrities of the day. This meeting gives an admirable opportunity, year after year, for watching the ravages of time and work. The young physicians and surgeons, as also those who have acquired reputation, but as yet little practice, are more or less pink and rosy; their nutrition is mostly good. But it is far different with the heads of the profession, with the men above fifty, on whose shoulders rests the weight of London consulting practice, and who are making large incomes: they are mostly pale, sallow, anæmic. As I walk about, I feel like Cassandra at the siege of Troy, and mentally prophesy evil—fatty hearts, atheromatous deposits in the arteries, degeneration of tissue, as the probable result of lives passed in contempt of the laws of hygiene and physiology.

What then, is to be done to avoid the evils of overwork in advancing age ? Many of our brethren cannot help themselves. They are like soldiers in battle; the *res angusta domi* offer an insuperable impediment. They cannot rest, they must go on. But many, on the other hand, could increase their chances of life if they would, by despising riches, by throwing their less remunerative practice into the hands of their juniors, by giving up public appointments, by limiting their labours to what their real, undisguised, unassisted mental powers would enable them to do, and, finally, by retiring, partially at least, from the field of action before life has been used up by work to the last dregs. What if they do retire on a pittance compared to previous gains? Does not the colonel, the admiral, retire on half-pay, and constantly live to extreme old age as the reward?

What applies to our medical brethren applies to all; and it is our duty to lay, nakedly and sternly, these facts before erring patients. Is it not very evident that we have recently lost one of our most distinguished literary men, Charles Dickens, at the early age of fifty-eight, from continued overstraining of the nervous system ?—in his case altogether without cause or excuse. On his return from America, he wrote that his readings during his tour in the States had much wearied and injured him. The constant travelling, the excitement of the meetings, the dinners, the receptions, had been too much for him. Had he then been made to understand that he was working against age and impaired vital power—risking his life, in a word—he might have taken rest and been with us now. But he continued the same labours, the same excitement; and died from brain disease, prematurely, regretted by a nation.

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